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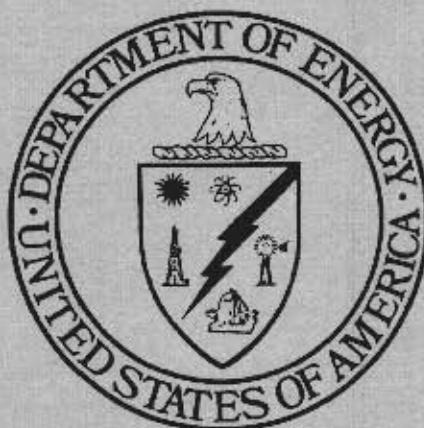
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**PROPOSAL FOR NO FURTHER ACTION  
ENVIRONMENTAL RESTORATION PROJECT  
SITE 50, OLD CENTRIFUGE SITE  
OPERABLE UNIT 1309**

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**June 1995**

**Environmental  
Restoration  
Project**



**United States Department of Energy  
Albuquerque Operations Office**

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# PROPOSAL FOR NO FURTHER ACTION

Site 50, Old Centrifuge Site  
Operable Unit 1309

SANDIA NATIONAL LABORATORIES/NEW MEXICO



# 1. Introduction

## 1.1 ER Site Identification Number and Name

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Environmental Restoration (ER) Site 50, Old Centrifuge Site, Operable Unit (OU) 1309. ER Site 50 is listed in the Hazardous and Solid Waste Amendment (HSWA) Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992).

## 1.2 SNL/NM Risk Based NFA Process

This proposal for a determination of a risk-based NFA decision has been prepared using the criteria presented in Section 4.5.3 of the SNL/NM Program Implementation Plan (PIP) (SNL/NM February 1994). Specifically, this proposal will "contain information demonstrating that this Solid Waste Management Unit (SWMU) has never contained constituents of concern that may pose a threat to human health or the environment" [as proposed in the Code of Federal Regulations (CFR), Section 40 Part 264.51(a) (2)] (EPA July 1990). The HSWA Module IV contains the same requirements for an NFA demonstration:

Based on the results of the RFI [RCRA Facility Investigation] and other relevant information, the Permittee may submit an application to the Administrative Authority for a Class III permit modification under 40 CFR 270.42 (c) to terminate the RFI/CMS [corrective measures study] process for a specific unit. This permit modification application must contain information demonstrating that there are no releases of hazardous waste including hazardous constituents from a particular SWMU at the facility that pose threats to human health and/or the environment, as well as additional information required in 40 CFR 270.42 (c) (EPA August 1993).

For a risk-based proposal, a SWMU is eligible for an NFA determination if the NFA criterion established by the SNL/NM permit is met. This criterion, found in Section M.1 of the permit, is as follows: "[T]here are no releases of hazardous waste including hazardous constituents...that pose threats to human health and/or the environment..." This risk-based proposal contains information needed to make the NFA determination.

This proposal is using the technical approach which is the foundation for the SNL/NM corrective action process. The details of the SNL/NM technical approach are provided in Appendix C of the PIP. The first step in the technical approach is the data qualitative review step (the same step used to determine whether the SWMU is eligible for administrative NFA). Should significant uncertainties remain, the assessment of the SWMU continues within the SNL/NM technical approach.

At this site, sufficient data were not available to compare to established action levels or to develop site-specific action levels. Background soil samples were collected and analyzed to

develop upper tolerance limits (UTLs) for metals. Site-specific data were collected to compare to existing soil action levels (proposed Subpart S action levels) (EPA July 1990) and background UTLs. If site-specific concentrations exceeded the proposed Subpart S action levels or UTLs, then risk was analyzed. The site-specific concentrations were compared to the derived risk assessment action levels. Concentrations less than these action levels, either proposed Subpart S action levels, background UTLs, or derived risk-based values, triggered this NFA proposal for Site 50.

### **1.3 Local Setting**

SNL/NM occupies 2,829 acres of land owned by the Department of Energy (DOE), with an additional 14,920 acres of land provided by land-use permits with Kirtland Air Force Base (KAFB), the United States Forest Service (USFS), the State of New Mexico, and the Isleta Indian Reservation. SNL/NM has been involved in nuclear weapons research, component development, assembly, testing, and other nuclear activities since 1945.

ER Site 50 (Figure 1) is located on land owned by DOE. The site is situated east of the Technical Area (TA) II fence in a slight depression on top of the escarpment northwest of Tijeras Arroyo.

Surficial deposits in the SNL/NM KAFB area lie within four geomorphic provinces, which in turn contain nine geomorphic subprovinces. Site 50 lies within the Tijeras Arroyo subprovince. The Tijeras Arroyo subprovince is characterized by broad, west-sloping alluvial surfaces and the 50-meter-deep Tijeras Arroyo. The Tijeras Arroyo subprovince contains deposits derived from many sources, including granitic and sedimentary rocks of the Sandia Mountains, sedimentary and metamorphic rocks of the Manzanita Mountains, and sediments of the Upper Santa Fe Group.

## **2. History of the SWMU**

### **2.1 Sources of Supporting Information**

In support of this request for a risk-based NFA decision for ER Site 50, a background study was conducted to collect available and relevant site information. Interviews were conducted with SNL/NM staff and contractors familiar with site operational history.

The following information sources were available for the use in the evaluation of ER Site 50:

- Confirmatory sampling program conducted in September 1994
- Risk analysis for four metals and five radionuclides
- One surface radiation survey
- One unexploded ordnance/high explosives (UXO/HE) survey
- Reconnaissance Soil Sampling (DOE January 1989)
- Interviews and personnel correspondence
- Historical aerial photographs spanning 40 years
- The Comprehensive Environmental Assessment and Response Program (CEARP) Phase I (DOE September 1987)

## ***2.2 Previous Audits, Inspections, and Findings***

ER Site 50 was first listed as a potential release site based on the CEARP interviews in 1985 (DOE September 1987), which noted that it was a rocket-powered centrifuge used to conduct acceleration tests on various weapon components. It was also noted in the CEARP that personnel do not recall any breakup of components that might have contaminated the area. However, there could be residual rocket propellants. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) finding was uncertain for Federal Facility Site Discovery and Identification Findings (FFSDIF), Preliminary Assessment, and Site Inspection; therefore, no Hazard Ranking System or Modified Hazard Ranking System migration mode scores were calculated for the SWMU (DOE September 1987). Site 50 was not included in the Environmental Protection Agency (EPA) RCRA Facility Assessment (RFA) in 1987 (EPA April 1987).

## ***2.3 Historical Operations***

The Old Centrifuge was an outdoor rocket-propelled centrifuge that was used in the early 1950s to test units under G forces. The concrete centrifuge pad has a diameter of 80 to 90 feet. The site has a 7-foot high wooden retaining wall on the north, west, and south sides. The east side is open. The centrifuge arm assembly, which has a 20-foot radius, is sitting outside the wall to the north and appears to be intact. Control wiring to the center axis of the centrifuge was suspended from a cable between two telephone poles on the north and south side of the pad. The control wiring went to a bunker located to the southwest over the escarpment. The bunker had an electrical transformer containing polychlorinated biphenyl (PCB)-bearing oil. The electrical transformer has been removed. No spills or leaks were reported.

The centrifuge was driven by two solid-fuel rocket motors. The combustion byproducts produced by these rocket motors were carbon dioxide, carbon monoxide, water, hydrochloric acid, aluminum oxide, and possibly barium oxide. No high explosives are known or suspected at the site. The rocket orientation would expel combustion byproducts toward the retaining wall and the opening to the east.

# **3. Evaluation of Relevant Evidence**

## ***3.1 Unit Characteristics***

The centrifuge pad has a diameter of 80-90 feet and is made of concrete. The site has a partial structural containment which consists of a 7-foot high wooden retaining wall on the north, west, and south sides. The east side is open.

## ***3.2 Operating Practices***

The retaining wall limited the area in which the rockets would expel combustion byproducts. The rocket propellant was consumed in the rocket motor case. Under normal operating conditions, no unburned propellant would be released.

### **3.3 Presence or Absence of Visual Evidence**

There is no discoloration of soils along the open eastern end of the centrifuge and the concrete pad is not stained.

### **3.4 Results of Previous Sampling/Surveys**

In 1987, a reconnaissance investigation was conducted at the Old Centrifuge Site. Samples were analyzed for uranium, trinitrotoluene (TNT), hue, saturation, lightness (HSL), inorganic constituents, toxicity characteristic leaching procedure (TCLP) constituents, and environmental protection (EP) toxicity constituents. Metals, including barium, were detected at concentrations well below regulatory action levels. Total uranium concentrations were typical of area background levels. TNT, pesticides, PCBs, herbicides, and semivolatile TCLP compounds were not detected. Additional information on this sampling program is in Appendix E.

In 1994, the site was visually surveyed for surface indications of UXO/HE. No UXO/HE were found (SNL/NM 1994a). Also in 1994, a surface radiation survey was conducted on the entire site using an Eberline ESP-2 portable scaler, with an Eberline SPA-8 (2 inch X 2 inch sodium iodide) detector. A 30-second integrated count was performed at each proposed sample location, while scanning the detector over an area approximately 2 feet in radius around the sample location. The alarm was set at 1.3 times the background count rate. No alarms occurred during the survey. No surface anomalies were detected (SNL/NM 1994b).

### **3.5 Assessment of Gaps in Information**

Due to the potential constituents of concern (metals, specifically lead, beryllium, and barium; depleted uranium<sup>1</sup>; and high explosives), contamination, if any, is not expected to be at shallow depths. Therefore, a surface (0-6 inches) and shallow subsurface (6-36 inches) soil sampling program was developed and implemented in September 1994.

### **3.6 Confirmatory Sampling**

The Confirmatory Sampling and Analysis Plan (SAP) can be found in Appendix A. Those soil sample results exceeding an action level are summarized in Table 1. A complete list of "hits" or detections and quality assurance (QA) results can be found in Appendix B. For health and safety purposes, a photoionization detector, OVM, was used throughout the field program. The OVM measured no anomalous vapor concentrations.

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<sup>1</sup> These constituents are related to combustion products.

Four surface samples and four subsurface samples were collected at the most likely area for contamination, along the open eastern end (Figure 1). Every sample was analyzed for metals<sup>2</sup>. Six samples were analyzed for explosive residues. As a general check for radioactive constituents, three samples were analyzed for tritium and isotopic uranium. One sample was analyzed for isotopic plutonium and two samples were screened with in-house gamma spectroscopy.

### *3.6.1 Background Samples for Metals and Radioactive Constituents*

UTLs for background metals were calculated from analyses of 24 samples collected in the vicinity of the 11 sites discussed in the SAP (Appendix A). UTLs or background 95<sup>th</sup> percentiles for background radionuclides were calculated from samples collected throughout KAFB (IT 1994). A discussion of background calculations and supporting data and analyses are included in Appendices C and D.

### *3.6.2 Explosive Residues*

No explosive residues were detected.

### *3.6.3 Metals*

Mercury, selenium, and silver were not detected at Site 50. All other site concentrations for metals, except one analysis for lead, were below UTLs. The maximum local background value for beryllium was 0.53 milligrams per kilogram (mg/kg). Beryllium was not detected above 0.53 mg/kg at Site 50. For lead, Sample 50-02-A had a concentration of 25 mg/kg, compared to a UTL of 23.1 mg/kg. A RCRA Subpart S action level was not proposed for lead. However, a memorandum from an assistant administrator to EPA regional division directors does supply a risk-based action level for lead in soils of 400 parts per million (ppm) (mg/kg) (EPA 1994). The metals data indicate acceptable environmental or human health risk.

### *3.6.4 Radionuclides*

Plutonium-239/240 and plutonium-238 were not detected above the minimum detectable activity (MDA) at Site 50. Uranium-238 and uranium-234 were detected in three samples with activities ranging from 0.52 to 0.58 picocuries per gram (pCi/g) for uranium-238 and 0.53 to 0.66 pCi/g for uranium-234. Uranium-235/236 was detected in two samples at activities of 0.023 and 0.028 pCi/g. All activities for uranium-238, uranium-234, and uranium-235/236 are below the base-wide background 95<sup>th</sup> percentiles and the maximum activities of the six local background analyses. Thallium was not detected at Site 50.

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<sup>2</sup> Although the TAL metal analytes include calcium, magnesium, potassium, and sodium, these non-toxic, major cations are not included in the evaluation. They do not pose a significant environmental or human health risk regardless of concentration.



Cesium-137 was detected with in-house gamma spectroscopy screens for Samples 50-01-A and 50-03-A at activities of 1.66 pCi/g and 2.82 pCi/g, respectively, compared with a base-wide background UTL of 0.92 pCi/g. Additional off-site analyses for cesium-137 on Samples 50-01-A and 50-03-A indicated lower activities. Tritium was detected in three samples at activities ranging from 0.020 to 0.038 pCi/g.

### **3.6.5 Quality Assurance Results**

As discussed in the Confirmatory Sampling and Analysis Plan (Appendix A), quality assurance samples, including field duplicates, trip blanks and rinsates, were collected as part of the 11-site sampling program. Analyses indicate that the field soil duplicates were comparable to the original soil sample results. The trip blanks and rinsates indicated no significant sampling contamination. QA results can be found in Appendix B. Level I and Level II data verification was conducted on all data, as described in the PIP (SNL/NM 1994).

### **3.7 Risk Analysis**

To further evaluate the site data for radionuclides with activities above the background UTL (cesium-137) or radionuclides without background UTLs (tritium), a risk assessment was performed for the combination of tritium and cesium-137, assuming the maximum detected activities.

The risk calculations were designed to produce conservatively large estimates of radioactive dose to counter uncertainties in the soil data. This approach facilitates the following decision regarding future activities at Site 50:

- If the conservative estimates based on the soil data result in an unacceptable dose (greater than 10 mrem/year), further investigation and/or remediation will be needed; or
- If the dose estimates are acceptable, the potential for health hazards at the site is extremely low, and further actions will not be needed.

Radionuclide doses were computed using methods and equations promulgated in proposed RCRA Subpart S documentation (EPA 1990). Accordingly, all calculations were based on the assumption that receptor doses from radionuclides result from ingestion of contaminated soil.

Calculation of radionuclide doses required values of dose conversion factors, which are used to convert radionuclide intakes (in units of pCi/year) into effective dose equivalents (in units of mrem/year). Published values of dose conversion factors (Gilbert et al., 1989) exist for tritium and cesium-137.

To assure that the computed doses were conservatively large, only the maximum observed activity of each constituent at a site was employed. To consider combined effects, a radiological dose was calculated as the sum of the individual doses.

Following proposed Subpart S methodology, the equation and parameter values used to calculate the summed radioactive dose were:

$$\text{DOSE} = \sum_i [\text{DSR}(i) \times \text{S}(i)] \quad (1)$$

where:

DOSE	=	total effective dose equivalent (mrem/yr);
DSR(I)	=	dose-to-soil concentration ratio for the $i^{\text{th}}$ radionuclide (mrem/yr)/(pCi/g), = $I \times \text{DCF}(I)$ ;
S(I)	=	soil concentration of the $i^{\text{th}}$ radionuclide (pCi/g);
I	=	soil ingestion rate = 0.2 g/day = 73 g/yr; and
DCF(I)	=	dose conversion factor for the $i^{\text{th}}$ radionuclide (mrem/pCi).

The PIP stipulates that, for the purpose of computing media action levels, the total radioactive dose at a site should not be greater than 10 mrem/year (SNL/NM 1994), which corresponds to a cancer risk of less than  $10^{-6}$  excess deaths.

The input and results of the risk calculations are presented in Table 2. The summed radioactive dose is less than 10 mrem/year. Therefore, the site is considered to be risk-free in terms of radionuclide contamination.

### **3.8 Rationale for Pursuing a Risk-based NFA Decision**

In September 1994, surface soil and shallow subsurface soil samples were collected at the open east side of the centrifuge, the most likely location for combustion byproducts from the rockets to settle and the most likely area to find contamination. SNL/NM is proposing a risk-based NFA because representative soil samples from ER Site 50 have concentrations less than action levels; either proposed Subpart S action levels, background UTLs, background 95<sup>th</sup> percentiles, or derived risk-based values.

In addition

- A site visit in 1993 and several visits in 1994 (August and September) by ER personnel confirmed no discoloration in the soils on the open east side of the centrifuge.
- In June 1994, a UXO/HE visual survey was conducted by KAFB Explosive Ordnance Division (EOD) and found no UXO/HE ordnance debris at Site 50 (SNL/NM 1994a).
- In September, 1994, as part of the surface soil sampling effort at Site 50, a surface radiation survey was conducted (SNL/NM 1994b). No surface anomalies were detected at Site 50.

## 4. Conclusion

Based upon the evidence cited above, ER Site 50 has no releases of hazardous waste or hazardous constituents that pose a threat to human health and/or the environment. Therefore, ER Site 50 is recommended for an NFA determination.

## 5. References

### 5.1 ER Site References

Gilbert, T.L., C. Yu, Y.C. Yuan, A.J. Zielen, M.J. Jusko, and A. Wallo, 1989. *Implementing Residual Radioactive Material Guidelines, A Supplement to U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Surplus Facilities Management Program Sites*, prepared by Argonne National Laboratory for U.S. Department of Energy, ANL/ES-160, DOE/CH/8901, 203 pp.

Guttman, I., 1970. *Statistical Tolerance Regions: Classical and Bayesian*. Hafner Publishing, Darien, Connecticut.

International Technology Corporation (IT), 1994. Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico Environmental Restoration Project Phase II: Interim Report.

U.S. Environmental Protection Agency (EPA), July 1994. *Guidance on Residential Lead-Base Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil*, memorandum from Lynn R. Goldman, M.D., USEPA Assistant Administrator to EPA Division Regional Directors.

U.S. Environmental Protection Agency (EPA), July 1990. "Corrective Action for Solid Waste Management Units (SWMU) at Hazardous Waste Management Facilities, Proposed Rule," *Federal Register*, Vol. 55, Title 40, Parts 264, 265, 270, and 271.

U.S. Environmental Protection Agency (EPA), 1989. "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance," U.S. Environmental Protection Agency, Office of Solid Waste, Waste Management Division, Washington DC.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A)." Office of Emergency and Remedial Response, Washington, DC. 20460.

Sandia National Laboratories/New Mexico (SNL/NM), 1994a. "Unexploded Ordnance/High Explosives (UXO/HE) Visual Survey of ER Sites Final Report, Albuquerque, New Mexico," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), 1994b. "Summary of Radiological Survey Results by SNL Dept. 7714 for ER Sites 50, 227, 229, 230-234," Sandia National Laboratories, Albuquerque, New Mexico.

## **5.2 Reference Documents**

Department of Energy (DOE), Albuquerque Operations Office, Environment and Health Division, Environmental Program Project Group, January 1989, Reconnaissance Data Report, Sandia National Laboratories Albuquerque."

Department of Energy (DOE), Albuquerque Operations Office, Environmental Safety and Health Division, Environmental Program Branch, September 1987, draft "Comprehensive Environmental Assessment and Response Program (CEARP) Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico."

Sandia National Laboratories/New Mexico (SNL/NM), August 1994. Environmental Restoration Project Information Sheet for Site 50, Old Centrifuge Site, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1994. Draft "Program Implementation Plan for Albuquerque Potential Release Sites," Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), April 1987. "Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico," Contract No. 68-01-7038, EPA Region VI.

U.S. Environmental Protection Agency (EPA), August 1993. "Module IV of RCRA Permit No. NM 5890110518, EPA Region VI," issued to Sandia National Laboratories, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), August 1992. "Hazardous Waste Management Facility Permit No. NM5890110518, EPA Region VI," issued to Sandia National Laboratories, Albuquerque, New Mexico.

## **5.3 Aerial Photographs**

Ebert & Associates, Inc., November 1994, "Photo-Interpretation and Digital Mapping of ER Sites 7,16,45,228 from Sequential Historical Aerial Photographs."

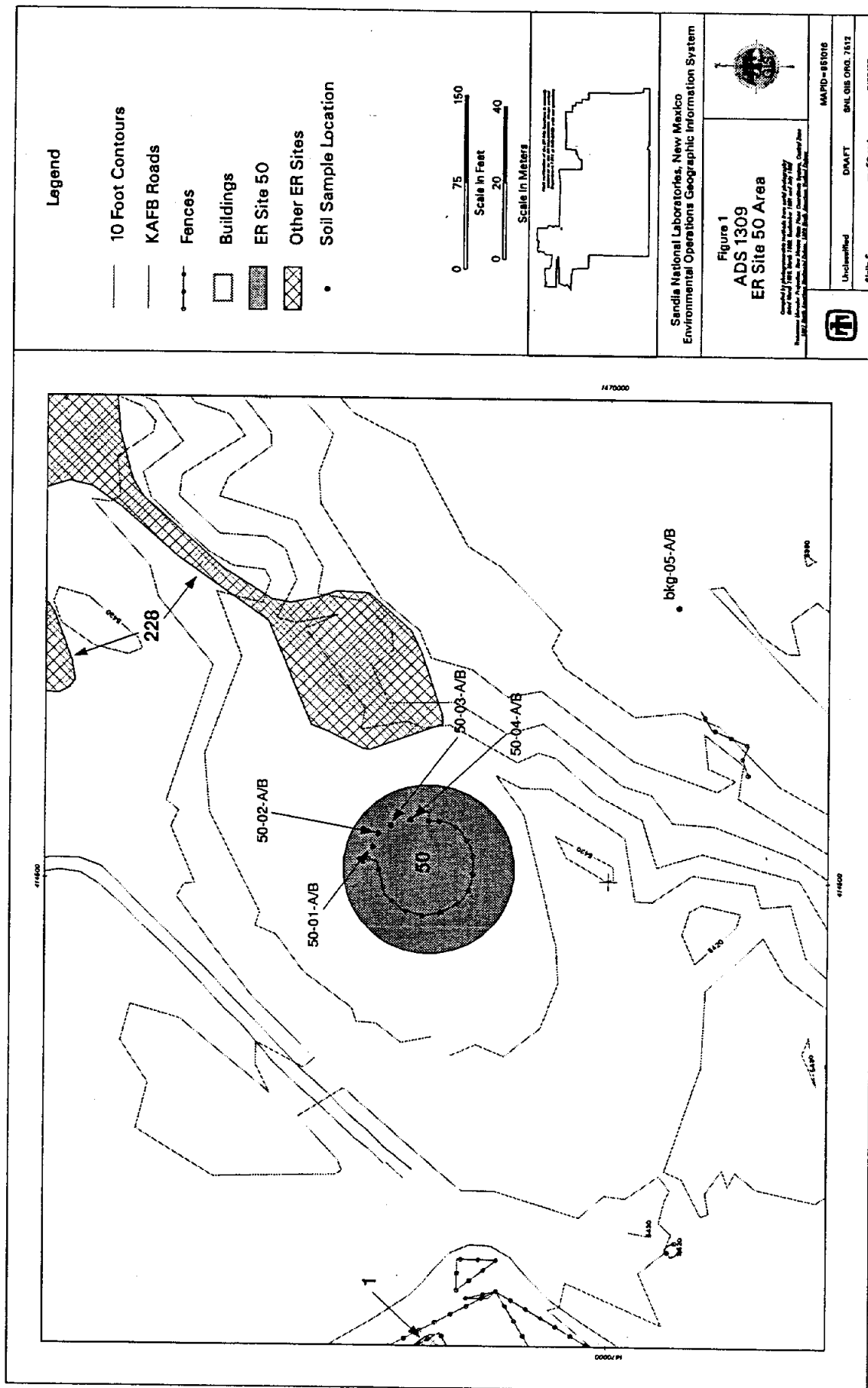


Figure 1. Old Centrifuge Site 50

Table 1. Site 50 Results of Shallow Soil Sampling and Analysis

Sample Identifier	Analytical Method	Constituent	Concentration <sup>1</sup>	Background <sup>2,3</sup>	Action Level <sup>4,5</sup>
50-02-A	TAL Metals (6010)	Lead	25	23.1	400
50-01-A	Tritium (600 906.0)	Tritium	0.024		36.9
50-01-B	Tritium (600 906.0)	Tritium	0.038		36.9
50-04-A	Tritium (600 906.0)	Tritium	0.02		36.9
50-01-A	Gamma Spec (in-house)	Cesium-137	1.66	0.92	274
50-01-A	Gamma Spec (in-house)	Cesium-137	2.82	0.92	274

Notes

<sup>1</sup>Lead concentrations are in mg/kg; tritium and cesium-137 activities are in pCi/g.

<sup>2</sup>For lead, background is the 95 percent UTL for the local background data.

<sup>3</sup>For cesium-137, background is the 95 percent UTL for the base-wide background data.

<sup>4</sup>The lead action level is from EPA, 1994.

<sup>5</sup>The tritium and cesium-137 action levels are calculated risk-based levels.

Table 2. Risk Calculations for Site 50

Constituent	Activity (pCi/g)	DCF(I) (mrem/pCi)	Individual Dose (mrem/year)	Source of DCF
Cesium-137	2.82E+00	5.00E-05	1.03E-02	Gilbert et al., 1989
Tritium	3.80E-02	6.30E-08	1.75E-07	Gilbert et al., 1989
Summed Dose			1.03E-02	



**APPENDIX A**

**Confirmatory Sampling and Analysis Plan**

**APPENDIX B**

**Analytical Results**

**APPENDIX C**

**Background Calculations for Metals and Radionuclides**

**APPENDIX D**

**Probability Plots, Local Background UTL Calculations, and Base-wide Background  
UTLs for Radionuclides**

**APPENDIX E**

**Summary of Reconnaissance Data Report**





# Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

## Introduction

The purpose of the sampling and analysis described in this plan is to determine the appropriate way to proceed toward closure of 11 ( of the 17) sites in the Tijeras Arroyo Operable Unit. Based on the surface and shallow subsurface soil samples and analyses for the constituents of concern (COCs), one of three approaches will be pursued for each site:

1. A petition for "No Further Action" (NFA) will be produced for regulatory consideration;
2. A voluntary corrective measure (VCM) will be designed and implemented, hopefully followed by an NFA petition; or
3. The site assessment and eventual closure will follow the standard RFI/CMS path

Most of the sites covered by this Sampling and Analysis Plan (SAP) are outfalls from the storm water and sanitary sewer systems emanating from Sandia Technical Areas (TAs) I, II, and IV. The general sampling program for the outfalls will be to collect four samples at the head of the outfall, two samples of surface soil (0 to 6 inches deep) and two samples of shallow subsurface soil (18 to 36 inches deep) and four samples (two surface soil and two shallow subsurface soil) at the furthest extent of channel erosion and scour. The analytes for most of the samples are volatile organic compounds, semi-volatile organic compounds (BNAs), metals, chromium<sup>+6</sup>, for samples where chromium is found in a metals analysis, total petroleum hydrocarbon (TPH), explosives, Total Kjeldahl Nitrogen (TKN), nitrate/nitrite, and Gamma Spectroscopy for radionuclides, isotopic uranium, isotopic plutonium, tritium, and chlorodiphenyls (PCBs).

## Sampling Procedures and Volumes

Surface soil samples will be collected with a stainless steel scoopula or trowel and placed in a stainless steel bowl. After at least 1000 ml<sup>1</sup> of soil has been collected, the soil will be thoroughly mixed in the bowl and transferred to two or three 500-ml sample bottles with a stainless steel scoopula. Sample bottles will be labeled accordingly and the appropriate sample information (sample depth, collection date and time, etc.) will be documented on the chain-of custody (COC) after each sample is collected. Samples will then be packaged and cooled to 4 degrees Celsius.

Shallow subsurface soil samples (18-36 inches) will be collected with a 2-inch (minimum) hand auger. A soil sample is collected by turning the auger clockwise and advancing it into the ground until the bucket at the end of the auger (last 6-8 inches) is full of soil or refusal occurs. Several runs with the auger is anticipated in order to obtain the appropriate volume. A hand shovel may also be used to bypass large rocks in order to continue with the auger. The auger is then extruded counter-clockwise from the ground and the soil is removed from the auger and placed in a stainless steel bowl. After 1,125<sup>2</sup> ml of soil has been collected, the soil will be mixed in the bowl and transferred to two or three 500-ml sample bottles and one 125-ml sample bottle with a stainless steel scoopula. Sample bottles will be labeled accordingly and the appropriate sample information will be documented on the COC after each sample is collected. Samples will then be packaged and cooled to 4 degrees Celsius.

## Waste Generation and Equipment Decontamination

Decontamination of sampling equipment will be done between each sample. Decontamination will include thoroughly washing the inside and outside of the sampling equipment with a spray of ALCONOX™ or LIQUINOX™ and water; rinsing with distilled,

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<sup>1</sup>The sample volume varies between 1,000 and 1,500 ml depending on the analyses for the sample.

<sup>2</sup>The sample volume varies between 1,125 and 1,625 ml depending on the analyses for the sample.

# Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

deionized water; and drying before reusing. No soil waste will be generated. The soil removed from the hand-auger holes, while collecting samples at a depth of 18 to 36 inches, will be return to the hole. The sampling tools, which are scoopulas/trowels, hand-augers, and shovels, will be decontaminated with water and ALCONOX™ after each use. The decon leachate will be stored in capped 1-gallon containers. One or two containers will be used for each site and two to four containers will be used for the background samples. The containers will be labeled as "IDW" and the site number identified on each container. All the containers will be stored at Site 232, a central location. The leachate waste will be disposed according to the analytical results of the soil samples collected at the site.

## Site Descriptions

The sites that will be sampled are

- Site 46, Old Acid Waste Line Outfall;
- Site 50, Old Centrifuge Site;
- Site 77, Oil Surface Impoundment;
- Site 227, Bldg. 904 outfall;
- Site 229, Storm Drain System Outfall;
- Site 230, Storm Drain System Outfall;
- Site 231, Storm Drain System Outfall;
- Site 232, Storm Drain System Outfall;
- Site 233, Storm Drain System Outfall;
- Site 234, Storm Drain System Outfall; and
- Site 235, Storm Drain System Outfall.

The site locations are shown in Figure 1. A description of the site history, conditions, previous investigations, and sampling plans are described in the following sections.

### Site 46: Acid Waste Line Outfall

The Old Acid Waste Line carried wastes from several buildings in TA I. The waste line begins as a north-south trending, 750-foot long open trench in a grassy field northwest of Building 981-1 in TA IV. No pipe opening is visible at the "head" of the trench. As the trench crosses the field, it turns to the southeast and continues to a non-engineered spillway at the edge of Tijeras Arroyo. The spillway lies on a bank (40 to 50 feet of relief) composed of compacted alluvial sediment. Historical aerial photographs show vegetation, presumably supported by the discharge, growing southeast of the spillway to the active arroyo channel (about 200 feet distance from the spillway). The site is not restricted and is easily accessible.

During use, discharged effluent averaged an estimated 130,000 gallons per day. Use of the line has been discontinued. The line received wastes from plating, etching, and photo processing operations, and cooling tower "blow down". Acids and metals are target contaminants. Chromic acid and ferric chloride are mentioned specifically in the site history, and ferric chloride was found in the soils during a limited sampling event. Various radionuclides, possibly including tritium, uranium, and plutonium were used in TA I.

Building 863 was a source of discharge to the Acid Line. The information sheet for ER Site 98 (Building 863, TCA Photochemical Release: Silver Catch Boxes) indicates the presence of trichloromethane, silver, and photo-processing chemicals with an ammonia-like odor. The waste solution from the silver recovery unit reportedly was discharged to the Old Acid Waste Line, which is the only specific information about chemical discharges.

The site has been visually surveyed for surface indications of unexploded ordnance and high explosives (UXO/HE). No UXO/HE were found. Also, a surface radiation survey was

## Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

conducted on the entire site. No surface radiation anomalies were detected.

The sampling program includes four samples collected at the "head" of the site outfall (by the fire extinguisher training area west of TA IV) and four samples collected by the spillway into the Tijeras Arroyo drainage (Figure 1). Every sample will be analyzed for tritium, metals, chromium<sup>+6</sup> (if chromium is detected), TKN, and nitrate/nitrite. Half the samples will also be analyzed for semi-volatiles and cyanide. Additionally, all the subsurface samples will be analyzed for volatiles. The analytes are listed in Table 1. A "4" on the table indicates that ALL the samples will be analyzed for that specific analyte whereas a "2" on the table indicates half the samples will have additional analyses for the analyte listed.

### Site 50: Old Centrifuge

Site 50, Old Centrifuge, was an outdoor, rocket propelled centrifuge that was used in the early 1950s to test units under G forces. The facility is located east of the TA II fence in a slight depression on top the escarpment northwest of Tijeras Arroyo. The concrete centrifuge pad has a diameter of 80 to 90 feet. The site has a 7-foot high wooden retaining wall on the north, east, and south sides. The west side is open. The centrifuge arm assembly, which has a 20-foot radius, is sitting outside the wall to the north and appears to be intact. Control wiring to the center axis of the centrifuge was suspended from a cable between two telephone poles on the north and south side of the pad. The control wiring went to a bunker located to the southwest over the escarpment. The bunker had a electrical transformer containing PCB. The electrical transformer has been removed. The pad was not stained and no spills or leaks were reported.

The centrifuge was rocket driven by two T40 6-KS-3000 or two Deacon 3.5DS-5700 solid rocket motors. The combustion byproducts produced by these rocket motors were carbon dioxide, carbon monoxide, water, hydrochloric acid, aluminum oxide, and possibly barium oxide. No other HE is known or suspected at the site. The rocket orientation would expel combustion byproducts towards the retaining wall and the opening to the west. The rocket propellant would be consumed in the rocket motor case. Under normal operating conditions, no unburned propellant would be released.

In 1987, a reconnaissance investigation at five potential contaminated sites, including the Old Centrifuge Site, was conducted by the ER Project. Samples were analyzed for uranium, TNT, HSL inorganics, TCLP constituents, and EP Toxicity constituents. Metals, including barium, were detected at concentrations well below regulatory action levels. Total uranium concentrations were typical of area background levels. TNT, pesticides, PCBs, herbicides, and semi-volatiles TCLP compounds were not detected.

Prior to sampling, the surface will be surveyed for radiation. If contamination exists, it is expected to be around the edge of the centrifuge pad at the surface, probably along the open west side. The constituents of concern are metals (specifically lead, beryllium, and barium), depleted uranium, and high explosives. Four surface samples and four subsurface samples will be collected. The sampling locations will be biased toward the west side of the site because that is the open side (Figure 1). All surface samples will be analyzed for all the COCs. One-half of the subsurface samples will be analyzed for uranium and high explosives. All four subsurface samples will be analyzed for metals.

### Site 77: Oil Surface Impoundment

The Oil Surface Impoundment Site is outside the TA IV fence, southeast of Building 981-1. The surface impoundment, which was constructed in the 1970's, is used to catch waste water from accelerators. At the time of the RCRA facilities environmental survey, the impoundment was unlined. Since then the impoundment was drained. Soil samples were analyzed for PCBs and

## Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

solvents. Based on the analytical results, the impoundment was determined to be clean. Subsequently, the impoundment was lined with geotextile and is now regulated under Sandia's Surface Water Discharge Program.

This site will not require UXO/HE or radiation surface surveys. Minimal confirmation sampling and analysis is proposed to verify that the site is clean. Three surface and three shallow subsurface samples are proposed. The samples will be collected along the perimeter of the existing lined pond (Figure 1). All the samples will be analyzed for PCBs. The subsurface soil samples also will be analyzed for volatile organic compounds (Table 1).

### Site 227: Bunker 904 Outfall

Site 227 is an inactive outfall from the septic system for Building 904 (ER Site 48) in TA II. The site starts where the discharge exits the septic tank piping system, approximately 100 feet northeast of the southernmost point of TA II. The extent of the area influenced by the discharge may include the bank of Tijeras Arroyo below the outfall and some area between the outfall and the main channel of Tijeras Arroyo. The site is along the eastern edge of ER Site 45.

Building 904, built in 1948, was used for weapons assembly, HE testing, photo processing, and various other testing. Sanitary wastes were discharged to a septic tank, and other wastes were discharged to the outfall.

Mineral oil is also being considered a potential soil contaminant at all outfalls along the Tijeras Arroyo due to a recent release (June 1994) of mineral oil at Outfall 232 and vague historical records.

Possible soil contaminants are explosives, radioactive materials from weapons processing, including tritium, uranium, and plutonium, solvents (acetone, methylene chloride, methyl ethyl ketone, carbon tetrachloride, toluene, xylene, hexane, alcohols), and inorganics (ammonium hydroxide, barium, cadmium, silver, chromium, titanium, cyanide).

Access to this site is along the TA II perimeter road. This site is within the TA II testing exclusion zone. The best days to sample are generally Friday, Saturday, and Sunday, when testing ceases. Bruce Berry (telephone 845-8018) must be contacted to gain permission and access to this site. Prior to sampling

1. tumbleweeds will be cleared from locations to be sampled and placed adjacent to the drainage;
2. these locations will be visually scanned for UXO/HE; and
3. these locations will be screened for surface radiation anomalies.

The proposed sampling program is to collect four surface soil samples and four shallow subsurface samples. Two surface and two subsurface samples will be collected at the outfall. The other two surface and two subsurface samples will be collected at the furthest visible channel erosion and scour (Figure 1). The analytes are listed in Table 1.

### Sites 229 - 235: Storm Drain Systems Outfalls

These sites consist of the discharge areas at seven outfalls along the northern embankment of Tijeras Arroyo. The outfalls discharged industrial effluent and storm water from TAs I, II, and IV. Presently they only discharge storm water. The outfalls receive runoff from Site 96 (Storm Drain System) and other engineered drain systems within the three TAs. The sites are along approximately  $\frac{3}{4}$  miles of the embankment.

The specific constituents in the industrial effluent at these sites are not known. The possible discharged contaminants include chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, and other petroleum products. To cover this array of possible contaminants, soil samples will be analyzed for volatiles (subsurface samples only), semi-volatiles, metals and chromium<sup>+6</sup>, if chromium is found in the metals analysis.

## Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

Mineral oil is also being considered a potential soil contaminant at all outfalls along the Tijeras Arroyo due to a recent release (June '94) of mineral oil at Outfall 232 and vague historical records. Therefore, soil samples will also be analyzed for TPH.

At Sites 229 through 234, prior to sampling

1. tumbleweeds will be cleared from locations to be sampled and placed adjacent to the drainage;
2. these locations will be visually scanned for UXO/HE; and
3. these locations will be screened for surface radiation anomalies.

*Site 229* is due east of the footings of the old guard tower and the south "corner" of the TA II fence. It discharges near the top of the embankment through the center of ER Site 45. Access to this site is along the TA II perimeter road. This site is within the TA II testing exclusion zone. The best days to sample are generally Friday, Saturday, and Sunday, when testing ceases. Bruce Berry (telephone 845-8018) must be contacted to gain permission and access to this site. Because this site discharges from TA II, various radionuclides, possibly including tritium, uranium, and plutonium are of concern. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

*Site 230* is west of Building 970 in TA IV. A drain pipe discharges into a bowl-shaped concrete structure adjacent to Building 970A. Flow from this structure is directed to a drain and flume located approximately 120 feet further west. The flume carries the flow to a discharge point slightly above the base of the arroyo embankment. Doug Bloomquist (845-7455) must be contacted to ensure that no laser testing is being performed in the area. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

*Site 231* is west of Building 970 in TA IV. A drain pipe discharges to a concrete flume near the top of the embankment. The flume carries the flow to a discharge point near the base of the slope. Doug Bloomquist (845-7455) must be contacted to ensure that no laser testing is being performed in the area. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

*Site 232* consists of two outfalls. One outfall is south of Building 970A, east of the lined lagoon. A drain pipe discharges to a concrete flume near the top of the embankment. The flume carries the flow to a discharge point near the bottom of hillside. On June 1, 1994, about 150 to 350 gallons of mineral oil was spilled into this outfall through the storm water drain by building 986. The day after the spill the site was screened for radiation and UXO/HE. No surface radiation anomalies or UXO/HE were found. Also, four surface soil and four subsurface soil samples were collected. The samples were sent to Quintera Laboratory in Denver for analysis for organics, metals, chromium<sup>6</sup>, and gamma spec. Other than TPH from the mineral, no contaminants were detected. A Voluntary Corrective Measure was conducted in July and August to remove soil contaminated with mineral oil above 100 mg/kg of TPH.

The second outfall in Site 232 also is south of Building 970A, west of lined lagoon, and approximately 120 feet east of the other Site 232 outfall. Discharge occurs from a concrete structure opening near base of embankment. Access to the site is along the road outside the south side of TA IV. Four surface soil and four subsurface soil samples will be collected at this drainage (Figure 1). The analytes are listed in Table 1.

*Site 233* is south-southwest of Building 986. Near the top of an escarpment, a small metal drain pipe discharges to an open drain which directs flow within another pipe before discharging near the base of the hillside. Access to the site is along the road outside the south side of TA IV. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

*Site 234* is southeast of Building 9811 (Inflatable Building) and a lagoon impoundment (Site 77).

## Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

The site discharges into a steep-sided, deeply incised channel cut into the hillside. The drainage channel splits directly uphill of a tree. Access to the site is along the road outside the south side of TA IV. Both channels will be sampled. Six surface soil and six subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 235 is immediately downstream of a large concrete spillway on the northeast side of Pennsylvania and south of the Skeet Range, at the point where the road comes off the north bank of the arroyo and descends into the channel. The flow moves in a confined channel after dropping down the spillway. The site has been cleared for visible surface UXO/HE and screened for surface radiation with no anomalies detected. This channel is considerably larger than the other outfall sites. Six surface soil and six subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

### Background

Background soil concentrations for organic contaminants should be negligible. Background concentrations for total metals and radionuclides must be determined for comparison to concentrations found at the sites. Twelve locations have been identified to collect samples for background determination (Figure 1). At each of these sites, one sample will be collected at a depth of 0-6 inches and a second sample collected at 18-36 inches (Table 1). In addition, the background study report prepared by International Technology Corporation (May 1994) will also be used to evaluate the data.

### Quality Assurance

As shown in Table 1, quality assurance samples will include the following:

- Field "duplicates" on more than 10 percent of the samples. These samples will be collected adjacent to the original surface soil sample and in the same hole as the original subsurface soil sample;
- Field soil blanks for more than 10 percent of the VOC analyses. These sample will be obtained from Sample Management Office (SMO) and will contain no VOCs; and
- One rinsate blank. All rinsate will be composited in one container. A sample of the rinsate will be analyzed for all constituents. The disposal method for the rinsate will be determined by the analytical results on this sample.

Site Name		Potential Contaminants	Ice Soils																Subsurface Soils																
46	Old Acid Waste Line Outfall (Tijeras Arroyo)	Ferric chloride, chromic acid and other acids, ammonla, photo processing chemicals and other unknown chemicals	Number of Samples	BNAs (8270)	TAL Metals (6010/7000)	Cr <sup>6+</sup> (aqueous leaching)	Cyanide (acid digestion)	TPH (8015)	Explosives Res (8330)	TKN (acid digestion)	NO <sub>3</sub> /NO <sub>2</sub> (353.2)	Gamma Spec (In-House) 600 901.1	Gamma Spec (Off-site) 600 901.1	PCBs (8080)	Tritium (600 906.0)	Isotopic Plutonium (600 7-79-081)	Isotopic Uranium (HASL-300 4.5)	Number of Samples	VOCs (8240)	BNAs (8270)	TAL Metals (6010/7000)	Cr <sup>6+</sup> (aqueous leaching)	Cyanide (acid digestion)	TPH (8015)	Explosives Res (8330)	TKN (acid digestion)	NO <sub>3</sub> /NO <sub>2</sub> (353.2)	Gamma Spec (In-House) 600 901.1	Gamma Spec (Off-site) 600 901.1	PCBs (8080)	Tritium (600 906.0)	Isotopic Plutonium (600 7-79-081)	Isotopic Uranium (HASL-300 4.5)		
50	Old Centrifuge Site (TA-2)	Rocket propellant and residues	4		4				4	4	4	2			4	2	2	4	4	4	2	4	4												
77	Oil Surface Impoundment	Solvents and PCBs	4															4	4																
227	Bldg. 904 outfall (TA-2)	High explosives, radioactive materials, nitrate, toluene, methanol, other solvents, carbon tetrachloride, ammonium hydroxide, barium, cadmium, silver, chromium, titanium, cyanide	4	2	4	4	2	2	2	4	4	4	2			4	2	2	4	4	2	4	4	2	4	4	2	4	4	4			4	2	2
229	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				4	2			4	2	2	4	4	2	4	4	4					4			4	2	2	
230	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2				2	1	1	4	4	2	4	4	4					2						
231	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2				2	1	1	4	4	2	4	4	4					2						
232	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2				2	1	1	4	4	2	4	4	4					2						
233	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2				2	1	1	4	4	2	4	4	4					2						
234	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	6	3	6	6		6				2				2	1	1	6	6	3	6	6	6					2						
235	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2				2	1	1	4	4	2	4	4	4					2						
Na	Background		12	12	12							12			3	3	3	12			12								12			3	3	3	
QA	Duplicates	Na	2	5	4	1	4	1	1	1		1	1	1		2			5	2	5	4	1	4	1	1	1				1		1		
QA	Field Soil Blank	Na																	5																
QA	Rinsate	Na	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1														
Totals			58	22	60	43	6	37	8	10	10	39	8	6	30	17	20	58	53	21	60	42	5	38	6	9	9	36	5	16	9	11			
Totals - Surface Plus Subsurface			116	43	120	85	11	75	13	19	19	75	8	11	46	26	31																		

\* Analyze for Cr<sup>6+</sup> only if Cr is detected in metals analysis





# **Appendix B**

## **Analytical Results**



# Site 50 Soil Results

Sample Identifier	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel
50-01-A	4000	9	8	210	0.4	1.6	96000	4	4.4	11	6100	22	3800	230	ND	5.2
50-01-B	3100	7	2	110	0.3	1.3	46000	4	3.9	6.2	7600	6.6	3000	130	ND	4.5
50-02-A	5800	12	4	220	0.4	1.6	120000	5	4.3	12	6700	25	4400	210	ND	7.1
50-02-B	2900	5	2	59	ND	1.1	21000	3	3.7	5.7	7100	7.5	2100	150	ND	4
50-03-A	3600	7	4	85	0.3	1.3	28000	4	3.8	8.1	7800	8.4	2600	170	ND	4.4
50-03-B	3200	8	2	110	ND	1.2	47000	4	3.7	6.6	7500	5.5	2600	140	ND	4.1
50-04-A	2600	6	5	96	ND	1.1	49000	3	3.3	4.6	6200	4.8	3000	140	ND	2.7
50-04-B	2100	5	3	91	ND	0.7	41000	2	2.9	4.4	4900	5.4	2500	120	ND	3

Sample Identifier	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Explosives Res.	Cesium-137	Cesium-137	Tritium	Plutonium-239/240	Plutonium-238	Uranium-238	Uranium-235/236	Uranium-234
50-01-A	1300	ND	ND	ND	ND	15	42	ND	1.7	1.8	0.02	0.00	0.00	0.6	0.03	0.7
50-01-B	810	ND	ND	ND	ND	17	18	ND			0.04			0.0	0.023	0.6
50-02-A	1300	ND	ND	ND	ND	11	69	ND								
50-02-B	1000	ND	ND	ND	ND	13	20									
50-03-A	1200	ND	ND	ND	ND	15	24	ND	2.8							
50-03-B	790	ND	ND	ND	ND	16	6.6	ND								
50-04-A	640	ND	ND	ND	ND	19	16	ND		ND	0.02			0.5	0.028	0.5
50-04-B	510	ND	ND	ND	ND	13	14									

Concentrations in mg/kg

Activities in pCi/g

Sample Identifier XX-XX-A - surface soil samples

Sample Identifier XX-XX-B - subsurface soil samples



**Quality Assurance Results for Inorganic and Radiological Constituents**

Sample Identifier	Sample Type	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Vanadium	Zinc
227-02-A	original	5800	9.3	5.9	180	ND	2.1	6.6	4.1	7.8	13000	7.5	160	ND	5.4	27	51
227-02-A	duplicate	6500	11	1.4	150	0.25	2.5	6.4	4.1	13	14000	9.1	170	ND	5.9	28	51
227-03-B	original	5100	8.8	0.92	140	ND	2.1	5.9	4.5	11	13000	7.5	200	ND	5.4	25	48
227-03-B	duplicate	6400	9.9	5.6	140	0.25	2.9	7.4	4.6	10	16000	8.9	230	ND	5.9	33	50
229-04-A	original	8100	13	5.7	150	0.32	2.3	8.0	4.2	7.9	13000	12	210	ND	6.3	24	55
229-04-A	duplicate	7700	12	1.5	140	0.30	2.2	8.0	4.2	7.7	12000	11	190	ND	6.2	24	52
230-04-B	original	1500	3.3	1.6	130	ND	0.61	2.3	ND	18	3500	4.2	110	ND	3.0	9.1	82
230-04-B	duplicate	2400	4.9	1.7	140	ND	0.68	3.1	2.5	15	4500	4.1	120	ND	3.4	9.7	71
235-01-A	original	3600	6.2	5.1	150	ND	2.7	6.0	8.4	6.6	20000	7.6	210	ND	4.5	36	66
235-01-A	duplicate	3000	5.3	1.3	160	ND	1.6	4.2	5.7	6.5	12000	9.4	180	ND	4.4	22	66
50-01-B	original	3100	6.5	2.1	110	0.25	1.3	4.1	3.9	6.2	7600	6.6	130	ND	4.5	17	18
50-01-B	duplicate	3900	7.5	2.0	110	0.26	1.3	4.3	4.0	5.7	8800	5.9	150	ND	4.2	18	21
50-02-A	original	5800	12	4.2	220	0.38	1.6	5.2	4.3	12	6700	25	210	ND	7.1	11	69
50-02-A	duplicate	7000	14	6.4	280	0.55	2.2	8.3	6.1	17	9000	35	290	0.04	9.4	18	61
Bkg-05-A	original	6400	13	5.7	210	0.53	1.8	6.1	6.6	14	10000	16	330	ND	8.9	22	37
Bkg-05-A	duplicate	5900	12	7.6	190	0.50	1.7	6.0	6.3	14	10000	16	320	ND	8.7	24	36
Site 235	rinsate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sample Identifier	Sample Type	TKN	NO <sub>3</sub> /NO <sub>2</sub>	Potassium 40	Lead 212	Lead 214	Plutonium 239/240	Uranium 238	Uranium 235/236	Uranium 234
227-02-A	original	400	2.7							
227-02-A	duplicate	320	9.3							
227-03-A	original						0.004	0.4	0.15	0.61
227-03-A	duplicate							0.67	0.023	0.67
227-03-B	original							0.72	0.11	0.72
227-03-B	original	220	ND							
227-03-B	duplicate			27.8	0.71	0.7				
227-03-B	duplicate	190	1.4							
229-01-A	original						0.007	0.45	0.17	0.67
229-01-A	duplicate							0.73	0.034	0.6
229-03-B	original							0.45	0.058	0.45
229-03-B	duplicate							0.99	0.06	1

**Notes on Quality Assurance Data**

Explosive residues were not detected in Site 50 duplicate sample

Hexavalent chromium was not detected in five duplicates and one decon rinsate

Cyanide was not detected in two duplicates and one decon rinsate

PCBs were not detected in one Site 77 duplicate sample

Tritium and Plutonium-238 were not detected in four duplicate samples

Selenium, silver, and thallium were not detected in any quality assurance samples



# **Appendix C**

## **Background Calculations for Metals and Radionuclides**



## Appendix C. Background Calculations for Metals and Radionuclides

To evaluate metals data, 24 background samples were collected for metals analyses.<sup>4</sup> Distribution analyses was performed first by constructing histograms. The histograms indicated a parametric distribution. Outliers were screened in a two-step process as described in the base wide background report (IT 1994). The first step is to perform an "a priori" screening for very high values relative to the rest of the data set. This is qualitatively performed by visually examining a column of sorted values. Maximum values that are a factor of 3 or 4 times higher than their nearest neighbor are removed from the data set during this step. None of the anomalous values were deleted by the "a priori" process.

The second step, from EPA, 1989, determines whether an observation that appears extreme fits the data distribution. A statistical parameter,  $T_n$  is calculated:

$$T_n = (X_n - X_a)/S$$

where:

$X_n$  = questionable observation;

$X_a$  = sample arithmetic mean; and

$S$  = sample standard deviation

$T_n$  is compared to a table of one-sided critical values for the appropriate significance level (upper 5 percent) and sample size from a table provided in EPA 1989. Extreme concentrations for barium, calcium, chromium, copper and nickel were identified as outliers and were excluded from the data set. These anomalous values may have resulted from laboratory or sampling error.

Probability plots were then replotted to determine whether the data fit normal or lognormal populations. These plots are shown in Appendix D. The UTL<sup>5</sup> was calculated for data sets that fit a normal or lognormal distribution. Data sets are provided in Appendix D. As recommended by EPA, a tolerance coefficient value of 95 percent was used (EPA 1989). Most metals background data fit lognormal distributions. Iron and zinc data fit normal distributions. UTLs were not calculated for mercury, selenium, and silver because mercury and selenium were not detected and silver was detected only once in the 24 background samples. The beryllium background data did not fit a normal or lognormal distribution. The maximum value in a data set is commonly taken as the UTL in a non-parametric setting (Guttman, 1970). The maximum background beryllium concentration was 0.53 mg/kg.

Base-wide background UTLs for radionuclides were established by International Technology (IT) Corporation to compare and evaluate radionuclide data (IT, 1994). A table is provided in Appendix

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<sup>2</sup>These data are referred to as local background data. The data collected throughout Kirtland Air Force Base (KAFB), with most of the data collected within SNL/NM technical areas, are called base-wide background data (IT 1994).

<sup>3</sup>UTL =  $x + K \cdot S$ , where:

UTL = Upper tolerance limit;

$x$  = Sample arithmetic mean (for normal distribution), sample geometric mean (for lognormal distribution);

$S$  = Sample standard deviation; and

$K$  = One-sided normal tolerance factor (95 percent for these evaluations).

D with radionuclide background data and the corresponding UTLs. The maximum activity from the six local background samples for isotopic plutonium and isotopic uranium was used as an additional method to evaluate the data. Also, in-house gamma spectroscopy was performed on all 24 background samples and indicated low levels of radioactivity but no significant contamination.



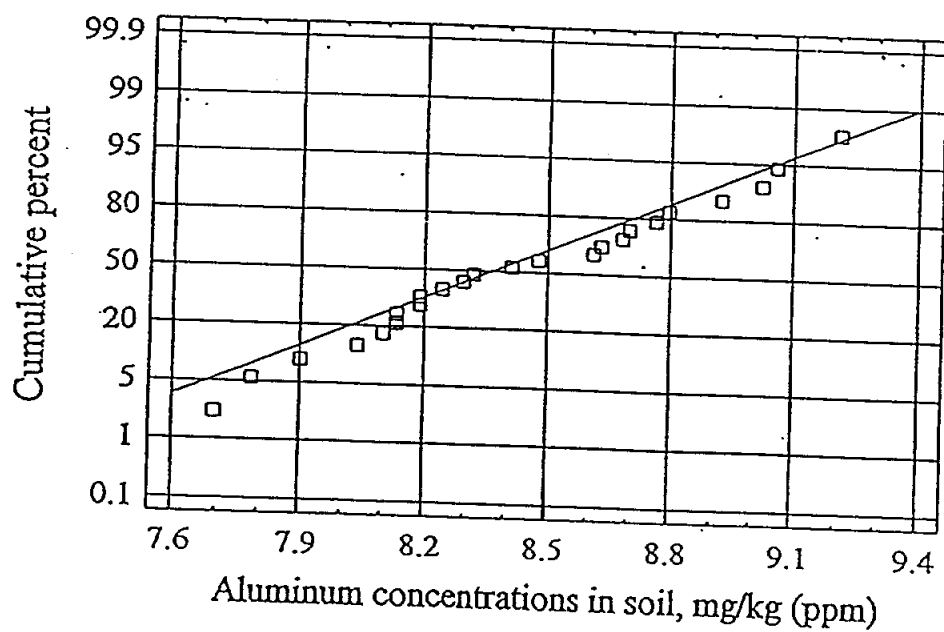
**Appendix D**  
**Probability Plots, Local**  
**Background UTL**

● **Calculations, and Base-**  
**Wide Background UTLs for**  
**Radionuclides**

Summary Statistics for log(Aluminum)

Count = 24  
Average = 8.42942  
Median = 8.36529  
Mode =  
Geometric mean = 8.41976  
Variance = 0.170246  
Standard deviation = 0.412609  
Standard error = 0.0842235  
Minimum = 7.69621  
Maximum = 9.21034  
Range = 1.51413  
Lower quartile = 8.13153  
Upper quartile = 8.73178  
Interquartile range = 0.600253  
Skewness = 0.132255  
Std. skewness = 0.26451  
Kurtosis = -0.792361  
Std. kurtosis = -0.792361  
Coeff. of variation = 4.89487  
Sum = 202.306

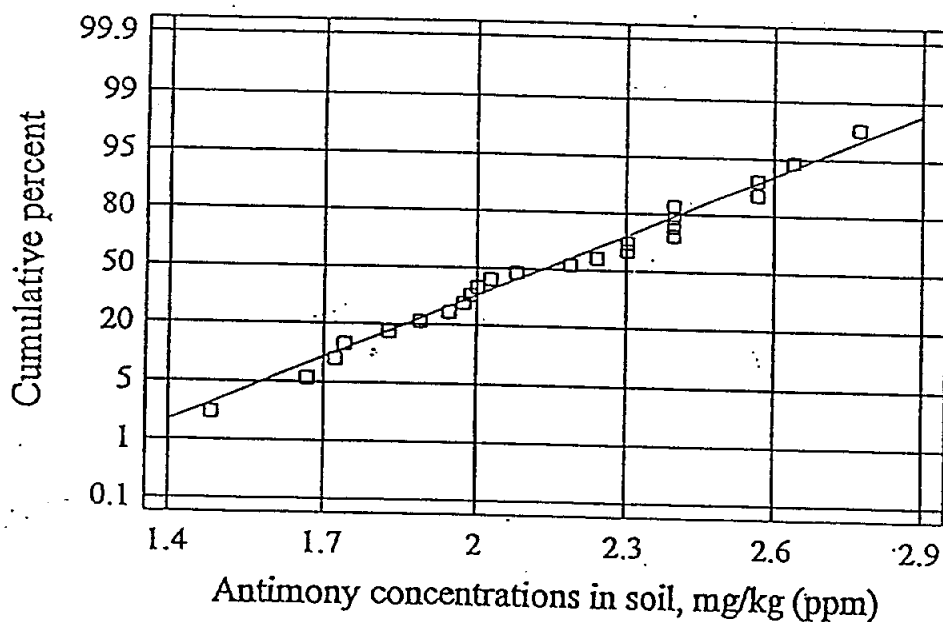
## Lognormal Probability Plot for Aluminum



# Summary Statistics for log(Antimony)

Sample size = 24  
 Average = 2.14609  
 Median = 2.13275  
 Mode = 2.3979  
 Arithmetic mean = 2.12004  
 Variance = 0.113831  
 Standard deviation = 0.337389  
 Standard error = 0.0668692  
 Minimum = 1.4816  
 Maximum = 2.77259  
 Range = 1.29098  
 Lower quartile = 1.91649  
 Upper quartile = 2.3979  
 Interquartile range = 0.481405  
 Skewness = -0.040772  
 Std. skewness = -0.0815441  
 Kurtosis = -0.744171  
 Std. kurtosis = -0.744171  
 Coeff. of variation = 15.7211  
 S = 51.5062

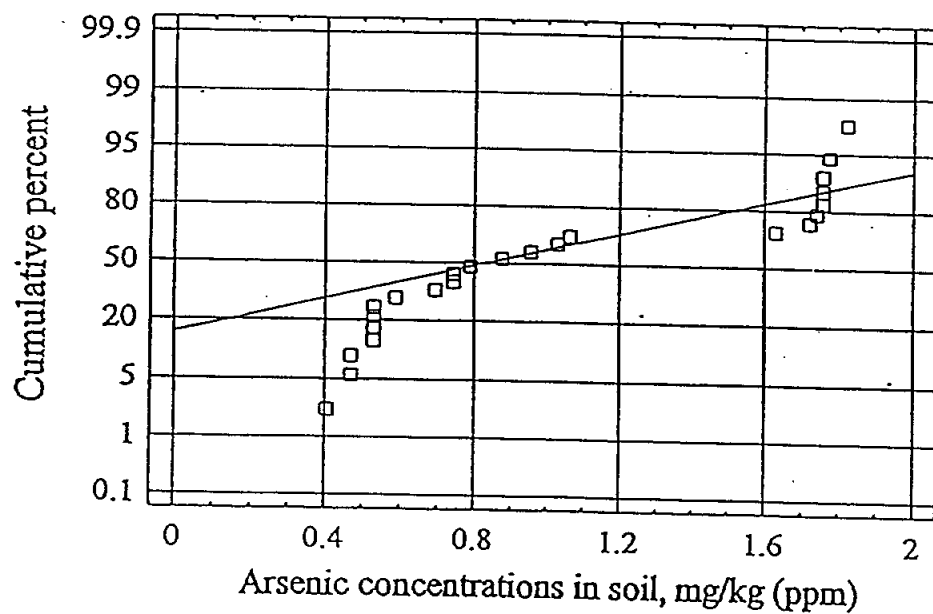
## Lognormal Probability Plot for Antimony



Summary Statistics for log(Arsenic)

Count = 24  
Average = 1.038  
Median = 0.031963  
Mode =  
Geometric mean = 0.908119  
Variance = 0.291153  
Standard deviation = 0.539586  
Standard error = 0.110143  
Minimum = 0.405465  
Maximum = 1.82455  
Range = 1.41908  
Lower quartile = 0.530628  
Upper quartile = 1.73162  
Interquartile range = 1.20099  
Skewness = 0.463036  
Std. skewness = 0.926071  
Kurtosis = -1.58507  
Std. kurtosis = -1.58507  
Coeff. of variation = 51.983  
Sum = 24.9121

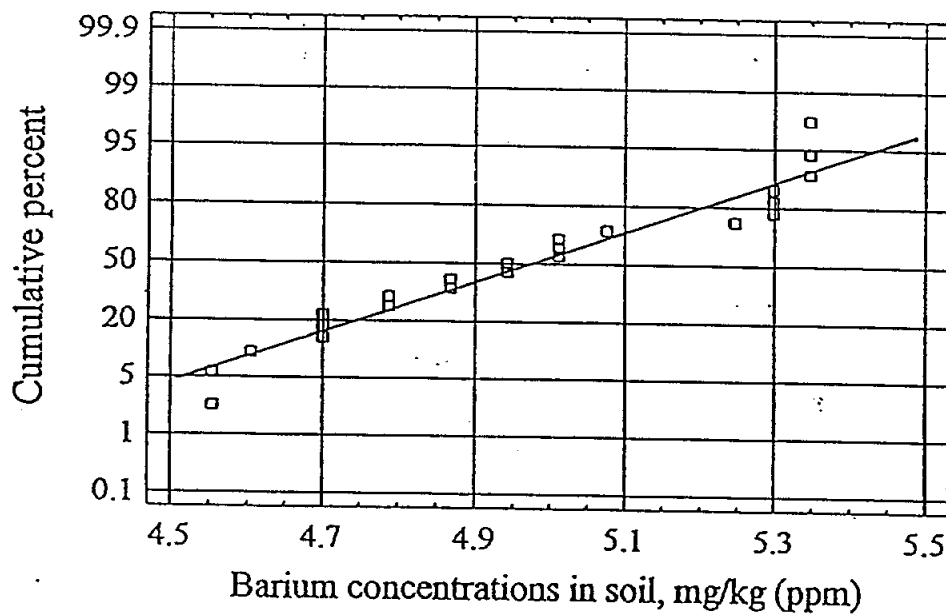
Lognormal Probability Plot for Arsenic



Summary Statistics for log(Barium)

n = 23  
case = 4.96940  
median = 4.94164  
mode = 5.34711  
arithmetic mean = 4.96236  
variance = 0.0740602  
standard deviation = 0.27214  
standard error = 0.0567451  
minimum = 4.55388  
maximum = 5.34711  
range = 0.793231  
first quartile = 4.70048  
third quartile = 5.29832  
interquartile range = 0.597837  
skewness = 0.0653415  
kurtosis = 0.127931  
coefficient of variation = -1.30542  
coefficient of kurtosis = -1.27794  
coefficient of variation = 5.47622  
variance = 114.298

## Lognormal Probability Plot for Barium

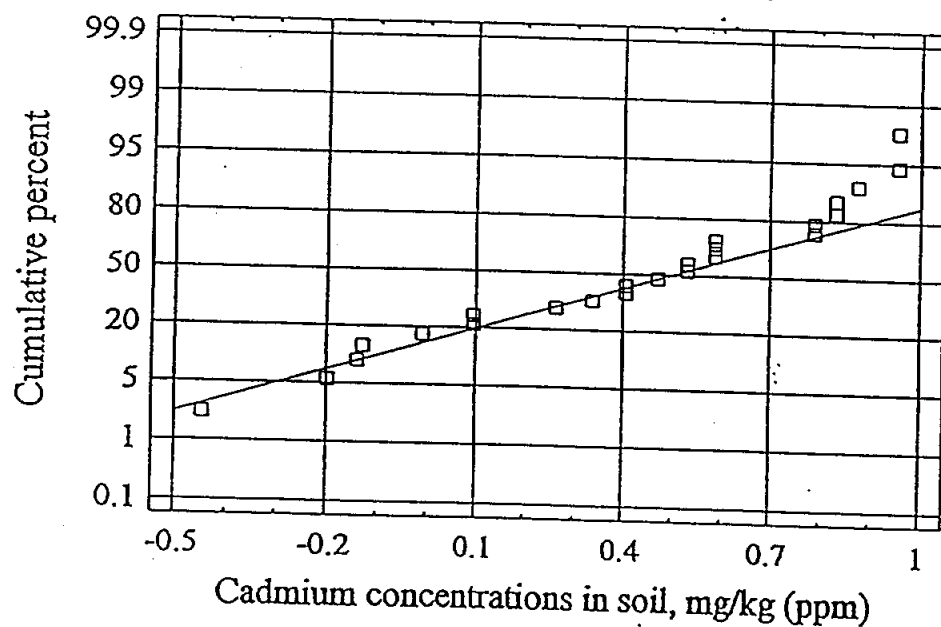




# Summary Statistics for log (Cadmium)

Count = 24  
Average = 0.416764  
Median = 0.500316  
Mode =  
Geometric mean =  
Variance = 0.159937  
Standard deviation = 0.399922  
Standard error = 0.0816337  
Minimum = -0.446287  
Maximum = 0.955511  
Range = 1.4018  
Lower quartile = 0.0953102  
Upper quartile = 0.788457  
Interquartile range = 0.693147  
Skewness = -0.506707  
Std. skewness = -1.01341  
Kurtosis = -0.674504  
Std. kurtosis = -0.674504  
Coeff. of variation = 95.9587  
Sum = 10.0023

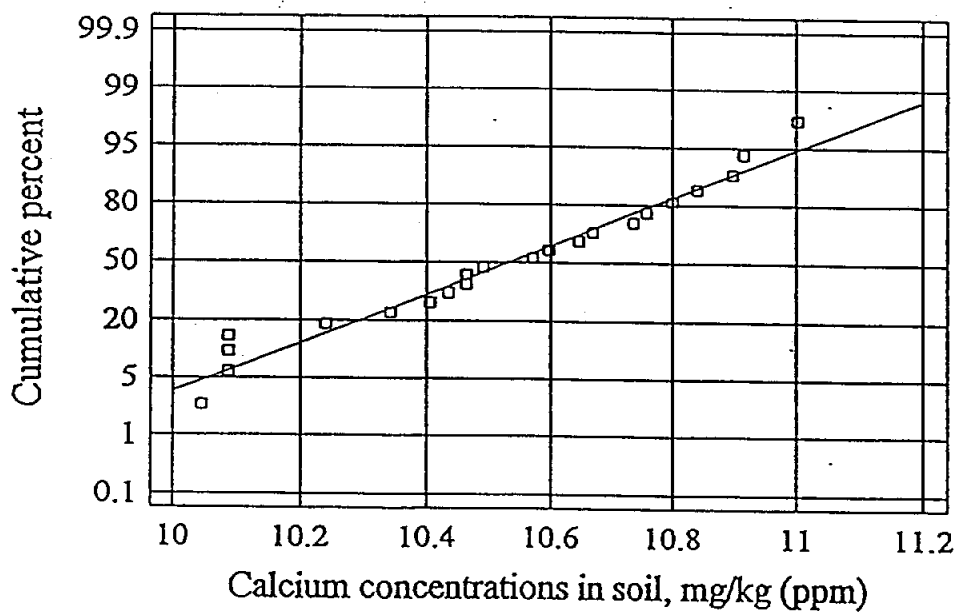
## Lognormal Probability Plot for Cadmium



# Summary Statistics for log(Calcium)

n = 23  
 mean = 10.5579  
 median = 10.5713  
 mode = 10.0058  
 geometric mean = 10.5532  
 variance = 0.10513  
 standard deviation = 0.324237  
 standard error = 0.0676081  
 minimum = 10.0432  
 maximum = 11.2645  
 range = 1.22121  
 lower quartile = 10.3417  
 upper quartile = 10.7996  
 interquartile range = 0.457833  
 skewness = 0.109797  
 std. skewness = 0.214971  
 kurtosis = -0.415646  
 std. kurtosis = -0.406895  
 coeff. of variation = 3.07103  
 s = 242.832

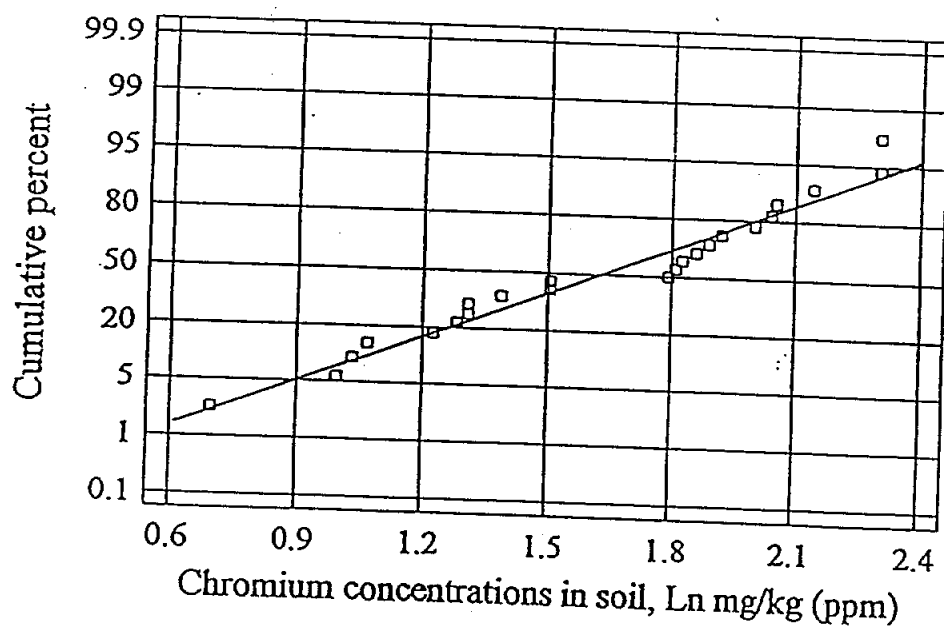
## Lognormal Probability Plot for Calcium



# Summary Statistics for log(Chromium)

Count = 23  
 Average = 1.61041  
 Median = 1.79176  
 Mode =  
 Geometric mean = 1.55042  
 Variance = 0.204195  
 Standard deviation = 0.451879  
 Standard error = 0.0942233  
 Minimum = 0.693147  
 Maximum = 2.30259  
 Range = 1.60944  
 Lower quartile = 1.28093  
 Upper quartile = 2.00148  
 Interquartile range = 0.720546  
 Skewness = -0.274151  
 Std. skewness = -0.536757  
 Kurtosis = -0.905395  
 Std. kurtosis = -0.886332  
 Coeff. of variation = 27.9211  
 Sum = 37.2235

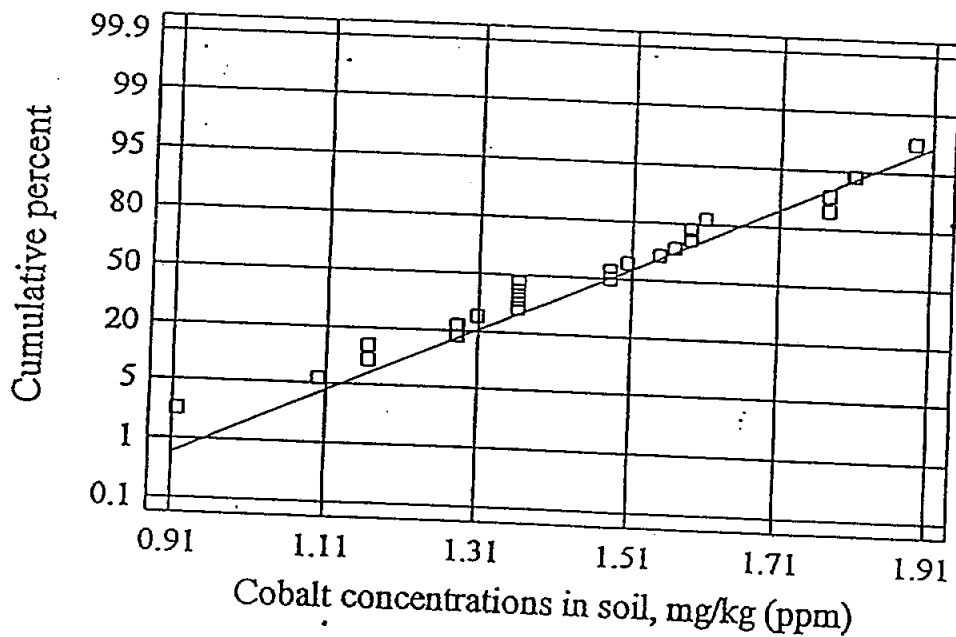
## Lognormal Probability Plot for Chromium



# Summary Statistics for log(Cobalt)

n = 24  
 average = 1.29969  
 median = 1.42129  
 mode =  
 geometric mean =  
 variance = 0.574775  
 standard deviation = 0.758139  
 standard error = 0.154754  
 minimum = -2.07944  
 maximum = 1.88707  
 range = 3.96651  
 lower quartile = 1.28093  
 upper quartile = 1.58924  
 interquartile range = 0.308301  
 skewness = -4.13299  
 std. skewness = -8.26598  
 kurtosis = 18.9091  
 std. kurtosis = 18.9091  
 coeff. of variation = 58.3324  
 n = 31.1925

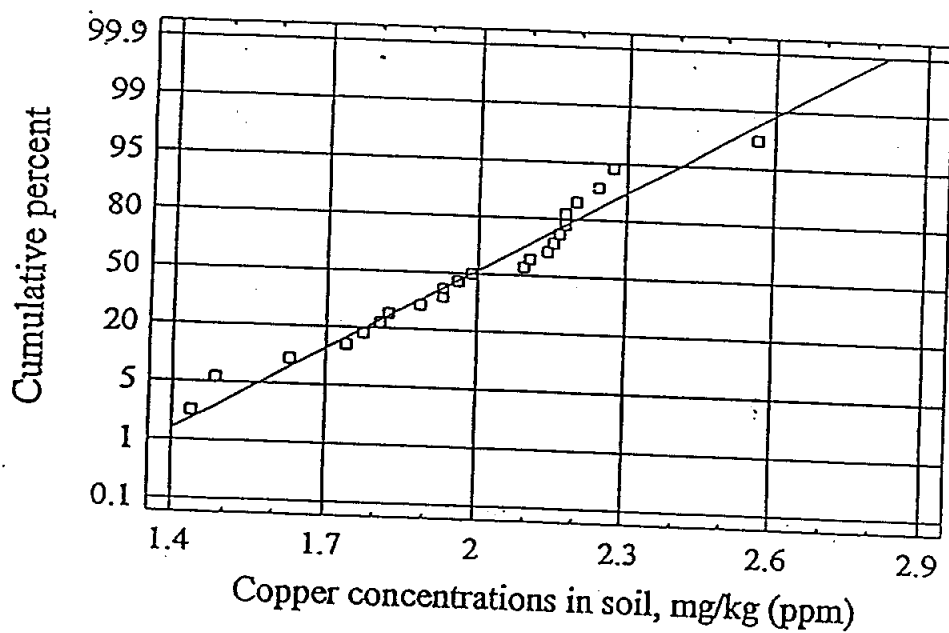
## Lognormal Probability Plot for Cobalt



Summary Statistics for log(Copper)

Count = 23  
Average = 1.98556  
Median = 1.98787  
Mode =  
Geometric mean = 1.96762  
Variance = 0.0713494  
Standard deviation = 0.267113  
Standard error = 0.0556969  
Minimum = 1.43508  
Maximum = 2.56495  
Range = 1.12986  
Lower quartile = 1.80829  
Upper quartile = 2.17475  
Interquartile range = 0.366463  
Skewness = -0.263077  
Std. skewness = -0.515077  
Kurtosis = 0.18883  
Std. kurtosis = 0.184854  
Coeff. of variation = 13.4528  
Sum = 45.6679

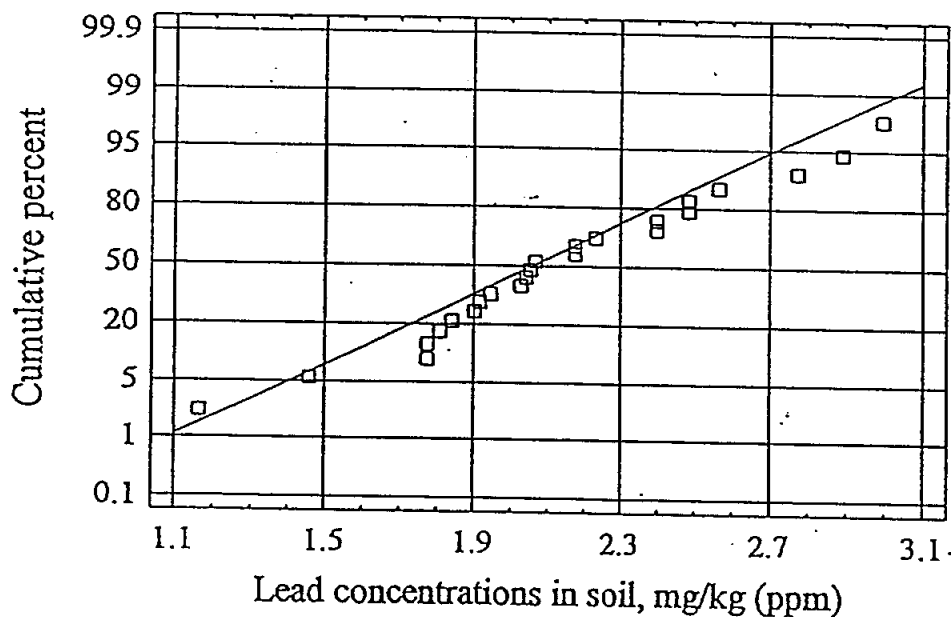
## Lognormal Probability Plot for Copper



# Summary Statistics for log(Lead)

n = 24  
 Mean = 2.13936  
 Median = 2.06049  
 Mode =  
 Harmonic mean = 2.09509  
 Variance = 0.187882  
 Standard deviation = 0.433454  
 Standard error = 0.0884784  
 Minimum = 1.16315  
 Maximum = 2.99573  
 Range = 1.83258  
 Lower quartile = 1.87133  
 Upper quartile = 2.4414  
 Interquartile range = 0.570072  
 Skewness = 0.0350174  
 Std. skewness = 0.0700348  
 Kurtosis = 0.200156  
 Std. kurtosis = 0.200156  
 Coeff. of variation = 20.261  
 n = 51.3446

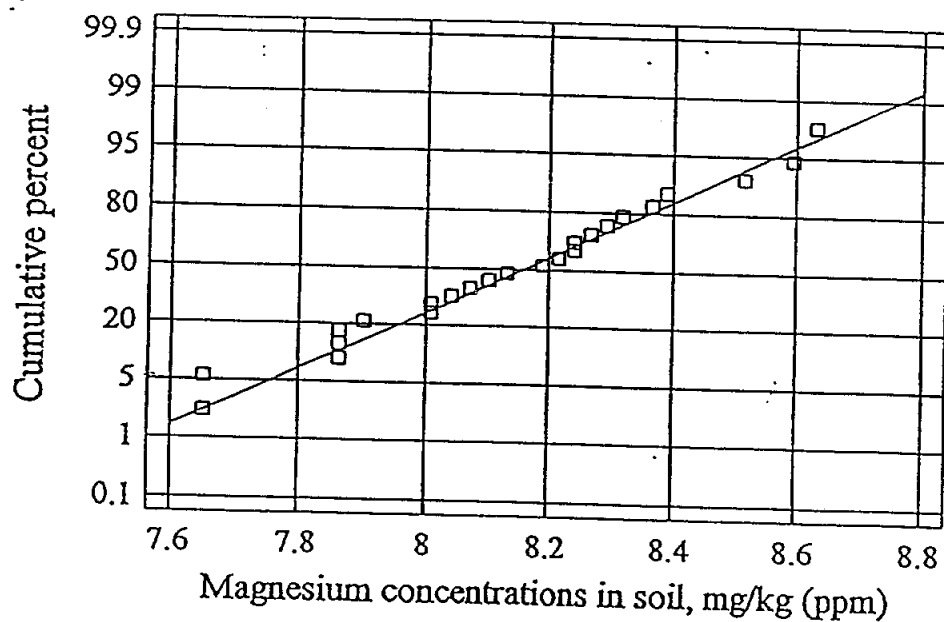
## Lognormal Probability Plot for Lead



# Summary Statistics for log (Magnesium)

Count = 24  
 Average = 8.14232  
 Median = 8.16011  
 Mode =  
 Geometric mean = 8.13815  
 Variance = 0.0706013  
 Standard deviation = 0.265709  
 Standard error = 0.0542376  
 Minimum = 7.64969  
 Maximum = 8.63052  
 Range = 0.980829  
 Lower quartile = 7.95369  
 Upper quartile = 8.3064  
 Interquartile range = 0.352709  
 Skewness = -0.0600481  
 Ind. skewness = -0.120096  
 Kurtosis = -0.414246  
 Ind. kurtosis = -0.414246  
 Coeff. of variation = 3.26331  
 Var = 195.416

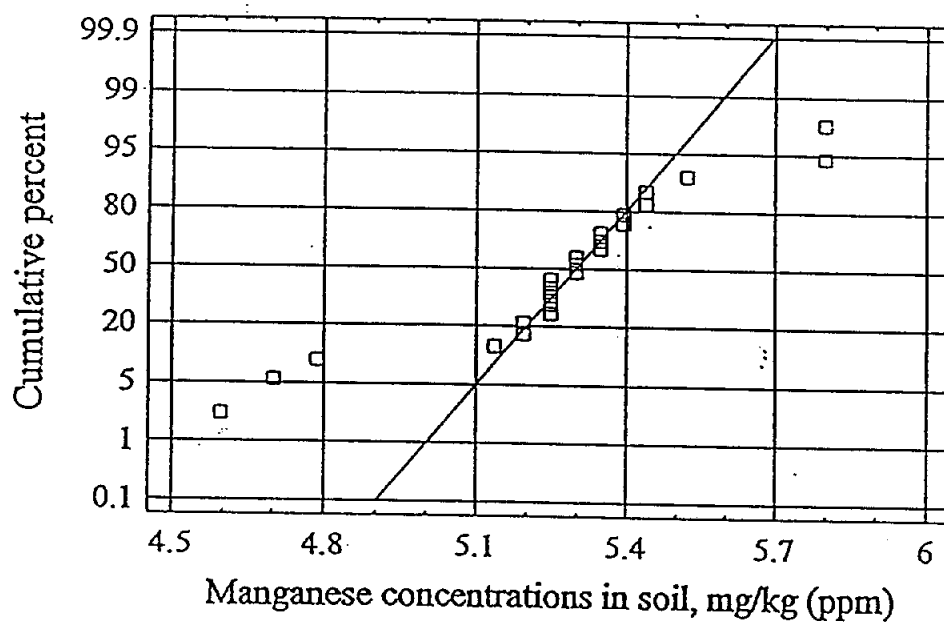
## Lognormal Probability Plot for Magnesium



# Summary Statistics for log(Manganese)

n = 24  
 average = 5.2733  
 median = 5.29832  
 mode =  
 geometric mean = 5.2661  
 variance = 0.0771874  
 standard deviation = 0.277826  
 standard error = 0.056711  
 minimum = 4.59512  
 maximum = 5.79909  
 range = 1.20397  
 lower quartile = 5.21999  
 upper quartile = 5.39363  
 interquartile range = 0.173637  
 skewness = -0.660387  
 std. skewness = -1.32077  
 kurtosis = 1.62566  
 std. kurtosis = 1.62566  
 coeff. of variation = 5.26854  
 sum = 126.559

## Lognormal Probability Plot for Manganese

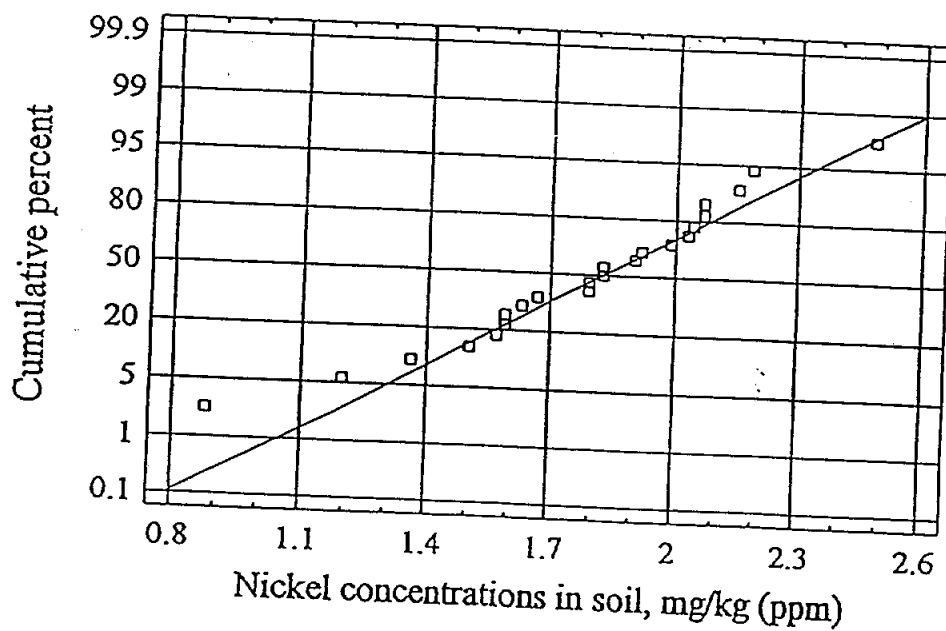




Summary Statistics for log(Nickel)

Count = 23  
Average = 1.70451  
Median = 1.82455  
Mode =  
Geometric mean = 1.74596  
Variance = 0.1246  
Standard deviation = 0.352987  
Standard error = 0.0736029  
Minimum = 0.875469  
Maximum = 2.48491  
Range = 1.60944  
Lower quartile = 1.58924  
Upper quartile = 2.04122  
Interquartile range = 0.451985  
Skewness = -0.609856  
Std. skewness = -1.19403  
Kurtosis = 0.992502  
Std. kurtosis = 0.971605  
Coeff. of variation = 19.7806  
Sum = 41.0438

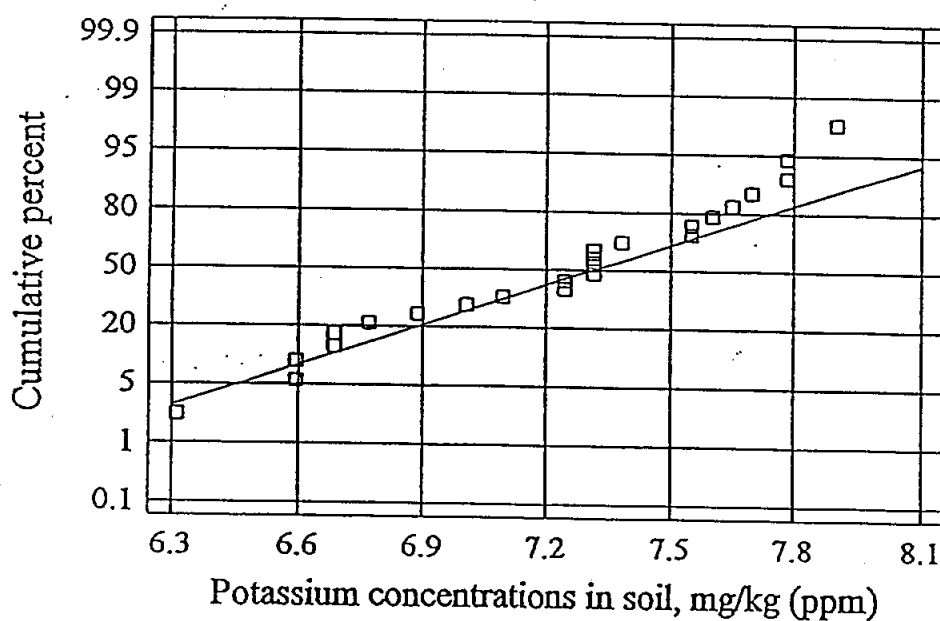
## Lognormal Probability Plot for Nickel



# Summary Statistics for log(Potassium)

n = 24  
 mean = 7.21862  
 median = 7.31322  
 mode = 7.31322  
 geometric mean = 7.20542  
 variance = 0.195599  
 standard deviation = 0.442265  
 standard error = 0.0902771  
 minimum = 6.30992  
 maximum = 7.90101  
 range = 1.59109  
 lower quartile = 6.82802  
 upper quartile = 7.57526  
 interquartile range = 0.747233  
 skewness = -0.373735  
 std. skewness = -0.74747  
 kurtosis = -0.83864  
 std. kurtosis = -0.83864  
 coeff. of variation = 6.12673  
 n = 173.247

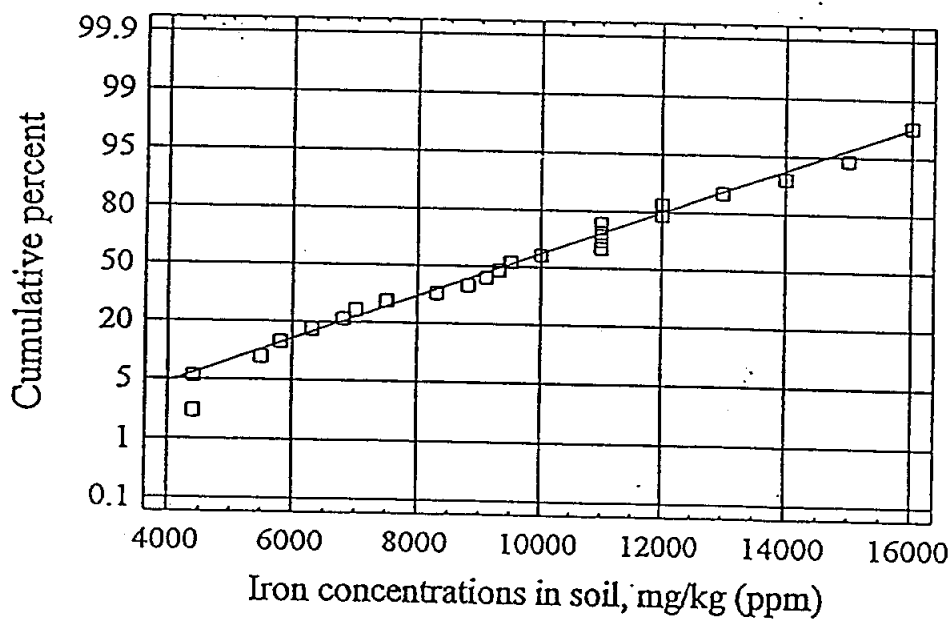
## Lognormal Probability Plot for Potassium



# Summary Statistics for Iron

Count = 24  
Average = 9529.17  
Median = 9400.0  
Mode = 11000.0  
Geometric mean = 8977.5  
Variance = 1.0363E7  
Standard deviation = 3219.17  
Standard error = 657.109  
Minimum = 4400.0  
Maximum = 16000.0  
Range = 11600.0  
Lower quartile = 6900.0  
Upper quartile = 11500.0  
Interquartile range = 4600.0  
Skewness = 0.20025  
Std. skewness = 0.400499  
Kurtosis = -0.620589  
Std. kurtosis = -0.620589  
Coeff. of variation = 33.7822  
Sum = 228700.0

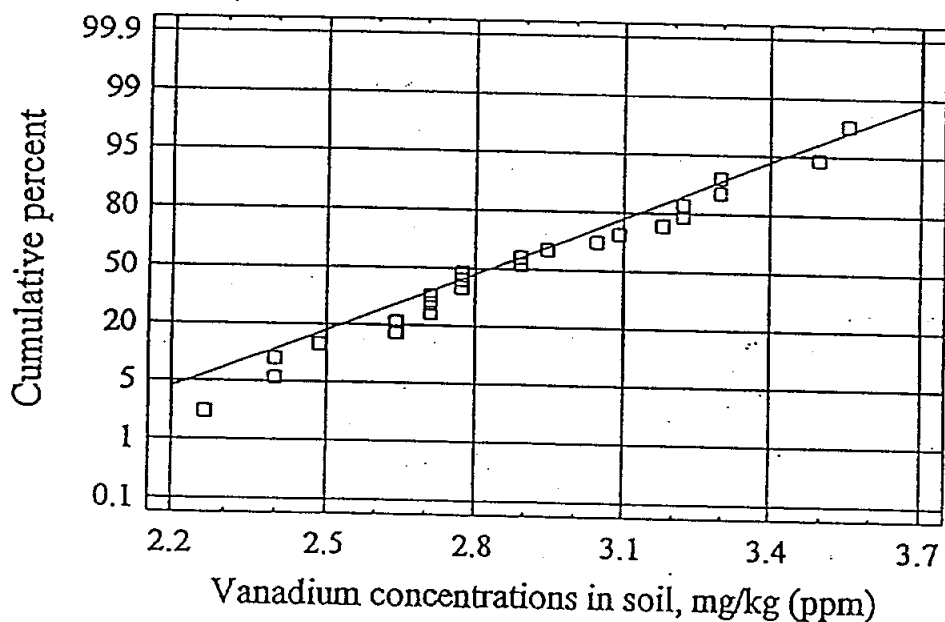
## Normal Probability Plot for Iron



Summary Statistics for log(Vanadium)

n = 24  
 mean = 2.89094  
 median = 2.83140  
 mode =  
 geometric mean = 2.87064  
 variance = 0.122444  
 standard deviation = 0.34992  
 standard error = 0.0714271  
 minimum = 2.26176  
 maximum = 3.55535  
 range = 1.29358  
 lower quartile = 2.67355  
 upper quartile = 3.19846  
 interquartile range = 0.524911  
 skewness = 0.158415  
 d. skewness = 0.316831  
 kurtosis = -0.688491  
 d. kurtosis = -0.688491  
 coefficient of variation = 12.104  
 = 69.3826

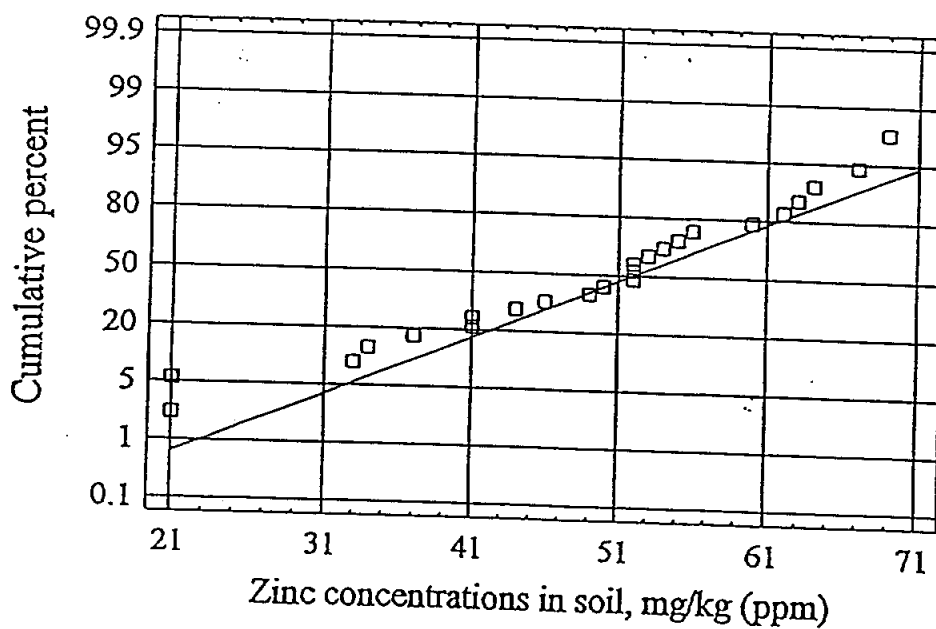
## Lognormal Probability Plot for Vanadium



# Summary Statistics for Zinc

Count = 24  
 Average = 49.0  
 Median = 52.0  
 Mode = 52.0  
 Geometric mean = 46.9434  
 Variance = 171.478  
 Standard deviation = 13.095  
 Standard error = 2.673  
 Minimum = 21.0  
 Maximum = 69.0  
 Range = 48.0  
 Lower quartile = 41.0  
 Upper quartile = 58.0  
 Interquartile range = 17.0  
 skewness = -0.633044  
 std. skewness = -1.26609  
 kurtosis = -0.0224531  
 std. kurtosis = -0.0224531  
 coeff. of variation = 26.7244  
 sum = 1176.0

## Normal Probability Plot for Zinc



# Local Background Soil Results

Sample Identifier	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury
Bkg-01-A	2700	6	2	110	ND	0.9	23000	3	3	6	5800	6	2100	190	ND
Bkg-01-B	4100	8	2	130	0.3	1.5	24000	5	4	7	8800	7	3100	230	ND
Bkg-02-A	2400	4	2	110	ND	0.8	35000	2	3	4	4400	3	2100	99	ND
Bkg-02-B	3400	7	2	130	ND	1	31000	3	3	6	6300	8	2700	210	ND
Bkg-03-A	4800	9	5	110	0.4	1.8	36000	6	5	9	11000	9	3700	210	ND
Bkg-03-B	6000	10	2	95	0.4	1.8	28000	7	5	9	11000	9	4400	250	ND
Bkg-04-A	4000	7	2	120	0.3	2.3	24000	9	4	13	9300	8	3000	190	ND
Bkg-04-B	3300	6	2	120	ND	1.4	24000	4	4	7	8300	6	2600	210	ND
Bkg-05-A	6400	13	6	210	0.5	1.8	78000	6	7	14	10000	16	5600	330	ND
Bkg-05-B	5500	10	6	140	0.5	1.7	33000	6	6	9	11000	11	3900	330	ND
Bkg-06-A	4500	9	6	150	0.3	1.5	46000	19	4	8	9100	8	3800	190	ND
Bkg-06-B	3800	8	2	150	0.3	1.1	51000	4	4	7	6800	7	3400	200	ND
Bkg-07-A	3100	6	2	95	0.3	1.1	34000	4	4	6	7000	12	2600	170	ND
Bkg-07-B	3600	7	3	100	0.3	1.3	39000	4	4	6	7500	7	3000	180	ND
Bkg-08-A	2200	5	6	160	ND	0.6	54000	3	ND	4	4400	4	2600	110	ND
Bkg-08-B	3600	7	3	190	ND	1.6	60000	5	4	7	9500	6	4100	180	ND
Bkg-09-A	5900	11	6	210	0.4	1.7	49000	6	5	7	11000	8	5400	230	ND
Bkg-09-B	3400	7	3	210	0.3	0.9	82000	3	3	5	5500	6	3800	120	ND
Bkg-10-A	7500	11	2	140	0.3	2.3	42000	8	5	8	13000	12	3200	190	ND
Bkg-10-B	6600	11	6	150	0.3	2.6	35000	7	4	10	14000	11	3300	200	ND
Bkg-11-A	8300	13	2	200	0.4	2.2	43000	8	5	9	12000	18	3600	190	ND
Bkg-11-B	10000	16	2	200	0.5	2.4	40000	10	6	9	16000	20	4000	220	ND
Bkg-12-A	5600	11	2	200	0.3	2.2	55000	7	5	9	12000	9	4300	200	ND
Bkg-12-B	8600	14	6	290	0.4	2.6	47000	10	6	9	15000	13	5000	220	ND

Concentrations in mg/kg

Activities in pCi/g

Sample Identifier XX-XX-A - surface soil samples

Sample Identifier XX-XX-B - subsurface soil samples

# Local Background Soil Results

Sample Identifier	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Tritium	Plutonium 239/24	Plutonium 238	Uranium-238	Uranium-235/236	Uranium-234
Bkg-01-A	4	1500	ND	ND	ND	ND	11	50						
Bkg-01-B	6	2000	ND	ND	ND	ND	16	63						
Bkg-02-A	2	730	ND	ND	ND	ND	9.6	41						
Bkg-02-B	5	1600	ND	ND	ND	ND	11	53						
Bkg-03-A	7	1500	ND	ND	ND	ND	19	56						
Bkg-03-B	9	1200	ND	ND	480	ND	15	62						
Bkg-04-A	12	1900	ND	1	ND	ND	18	55	<0.010	<0.009	<0.011	0.8	0.28	1
Bkg-04-B	5	1400	ND	ND	ND	ND	16	52	<0.022	<0.008	<0.009	0.3	0.02	0.3
Bkg-05-A	9	2700	ND	ND	ND	ND	22	37						
Bkg-05-B	8	1400	ND	ND	ND	ND	18	34						
Bkg-06-A	13	1500	ND	ND	ND	ND	16	52						
Bkg-06-B	6	800	ND	ND	420	ND	14	54						
Bkg-07-A	5	870	ND	ND	ND	ND	15	21						
Bkg-07-B	5	800	ND	ND	380	ND	15	21						
Bkg-08-A	3	730	ND	ND	ND	ND	12	33						
Bkg-08-B	5	980	ND	ND	430	ND	21	67						
Bkg-09-A	8	1100	ND	ND	280	ND	24	41						
Bkg-09-B	5	550	ND	ND	640	ND	14	44						
Bkg-10-A	6	2400	ND	ND	ND	ND	27	52						
Bkg-10-B	7	2200	ND	ND	ND	ND	27	49						
Bkg-11-A	7	2100	ND	ND	280	ND	25	60	<0.023	<0.007	<0.017		0.03	0.5
Bkg-11-B	8	2400	ND	ND	290	ND	35	64	<0.024	<0.012	<0.018		0.03	0.6
Bkg-12-A	6	1500	ND	ND	ND	ND	25	46	<0.084	<0.030	<0.017		0.17	0.8
Bkg-12-B	8	1900	ND	ND	620	ND	33	69	<0.023	0.035	0.038	0.6	0.33	0.9

Concentrations in mg/kg

Activities in pCi/g

Sample Identifier XX-XX-A - surface soil samples

Sample Identifier XX-XX-B - subsurface soil samples

Normal Parameters for Tijeras Arroyo Local Metal Background Data

Statistical Parameter	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc
median	4300	8.5	2	140	2	6	4.2	7.3	9400	7.9	200	6.2	17	52
geometric mean	4579.9	8.6	3	144	2	5	3.7	7.3	8977.5	8.5	195	6	18	47
maximum	10000	16	6	210	3	10	6.6	13	16000	20	330	12	35	69
minimum	2200	4.4	2	95	1	2	0.1	4.2	4400	3.2	99	2.4	9.6	21
arithmetic average	4970.8	9	3	149	2	5.5	4.2	7.5	9529.2	9.3	202	6.3	19	49
standard deviation	2095.4	3	2	40.5	1	2.3	1.3	2	3219.2	4.2	53.6	2.1	6.9	13
normal tolerance	2.309	2.3	2	2.33	2	2.3	2.3	2.3	2.309	2.3	2.31	2.3	2.3	2.3
UTL	4927.4	16	7	244	3	11	7.3	12	16962	19	326	11	35	79

Lognormal Parameters for Tijeras Arroyo Local Metal Background Data

Statistical Parameter	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc
arithmetic average	8.4294	2.2	1	4.97	0	1.6	1.3	2	9.1025	2.1	5.27	1.8	2.9	3.8
standard deviation	0.4126	0.3	1	0.27	0	0.5	0.8	0.3	0.3631	0.4	0.28	0.4	0.3	0.3
normal tolerance	2.309	2.3	2	2.33	2	2.3	2.3	2.3	2.309	2.3	2.31	2.3	2.3	2.3
UTL	9.3821	2.9	2	5.6	1	2.7	3.1	2.6	9.941	3.1	5.91	2.6	3.7	4.6
e <sup>UTL</sup>	11874	19	10	271	4	14	21	14	20764	23	370	14	40	98

Sufficient data for mercury, selenium, silver, and thallium to calculate statistics  
 All concentrations in mg/kg



# Summary of Background Concentrations for Radionuclides in Soil

Analyte	Original Number of Samples	Number of Detects	Number of Rejected Samples	Distribution Type	Range (pCi/g)	n*	Geometric Mean (pCi/g)	Median (pCi/g)	95 <sup>th</sup> Upper Tolerance Limit (pCi/g)	95 <sup>th</sup> Percentile (pCi/g)
Bismuth-212	324	17	307	Nonparametric	0.414-2.7	17	1.1055	1.0	-	2.7
Bismuth-214	340	321	19	Nonparametric	0.27-1.4	321	0.848	0.6	-	0.8
Cesium-137 (Surface) (Subsurface)	802	561	26	Nonparametric	0.004-10.1	604	0.200	0.2495	-	0.92
	-	-	-	Unknown	<detection limit (<0.0686)	172	<detection limit (<0.0686)	<detection limit (<0.0686)	-	<detection limit (<0.0686)
Cobalt-60	321	11	74	Unknown	<detection limit (<0.0418)	247	<detection limit (<0.0418)	<detection limit (<0.0418)	-	<detection limit (<0.0418)
Lead-210*	338	40	292	Nonparametric	0.3-12.0	46	2.26838	2.835	-	6.8
Lead-212*	323	233	90	Lognormal	0.1-1.4	233	0.49689	0.5	1.0795	-
Lead-214*	249	241	9	Lognormal	0.29-1.13	240	0.549	0.56	0.90	-
Potassium-40	722	720	4	Normal	0.192-31.0	718	15.889	16.4	25.34	-
Radium-224	24	24	0	Nonparametric	0.43-0.97	24	0.6747	0.655	-	0.568
Radium-226	368	53	314	Lognormal	0.5-2.09	54	0.713	0.590	1.94	-
Radium-228	24	24	0	Nonparametric	0.45-1.05	24	0.695	0.630	-	1.05
Radon	0	0	0	Unknown	-	0	-	-	-	-
Strontium-90	54	45	9	Nonparametric	0.032-1.85	45	0.2528	0.2883	-	0.766
Thorium-232	136	136	0	Lognormal	0.23-1.20	136	0.7971	0.810	1.258	-
Thorium-234	365	52	330	Lognormal	0.324-3.0	35	0.7796	0.71	2.89	-
Tritium	0	0	0	Unknown	-	0	-	-	-	-
Uranium-234	4	4	0	Nonparametric	0.8-1.0	4	0.897	0.9	-	1.0
Uranium-235	95	21	75	Nonparametric	0.05-0.18	20	0.1198	0.1235	-	0.168
Uranium-238	223	206	17	Nonparametric	0.0033-2.065	206	0.506	0.763	-	1.1

\*Sample size.

\*These constituents are not listed as COC in Table 2-2 for this media.

\*Constituents of concern are of unknown distribution type because data are either below the limit of detection, unusable, or nonexistent.

(IT, 1994)

# **Appendix E**

## **Summary of**

### **Reconnaissance Data**

#### **Report**

The Site 50 reconnaissance study included analysis of eleven soil samples. The sample locations are shown in Figure E-1. Most of the analyses were non-detections. The non-detected parameters, the applied methods, and detection limits are listed in Tables E-1 and E-2. The detected constituents and the range of concentrations are shown in Table E-3. The level of quality assurance/quality control corresponded to EPA procedures and standard commercial standards available in 1987. Five SNL/NM Environmental Program procedures were followed in sample collection:

- 1.1 General Instructions for Field Personnel (revision 0)
- 1.3 Sample Control and Documentation (revision 0)
- 1.4 Sample Containers and Preservation (revision 0)
- 1.6 General Equipment Decontamination (revision 0)
- 5.2 Soil Sampling with a Spade and Scoop (revision 0)

One rinsate blank was collected for the 10 field samples and was analyzed for HSL inorganic constituents. One "duplicate" sample<sup>1</sup> was collected and the relative percent difference between the original sample and the duplicate was calculated and reported for detected constituents.

Table E-1. Non-Detected Constituents (inorganic)

Constituent	Analytical Method	Detection Limit (mg/kg)	Constituent	Analytical Method	Detection Limit (mg/kg)
Silver	HSL Inorganic	1.8 to 2.0	Silver	TCLP Metals	0.5
Beryllium	HSL Inorganic	0.91 to 1.0	Arsenic	TCLP Metals	0.5
Cadmium	HSL Inorganic	0.91 to 1.0	Cadmium	TCLP Metals	0.1
Cerium	HSL Inorganic	18.2 to 20.0	Chromium	TCLP Metals	0.5
Cobalt	HSL Inorganic	9.1 to 10.0	Mercury	TCLP Metals	0.2
Mercury	HSL Inorganic	0.1	Lead	TCLP Metals	0.5
Nickel	HSL Inorganic	7.3 to 8.0	Selenium	TCLP Metals	0.1
Antimony	HSL Inorganic	11.5 to 12.0	Silver	EP Toxicity	0.1 to 0.5
Thallium	HSL Inorganic	1.9 to 2.0	Arsenic	EP Toxicity	0.5
Zirconium	HSL Inorganic	18.2 to 20.1	Cadmium	EP Toxicity	0.5
Chromium	EP Toxicity	0.5	Lead	EP Toxicity	0.5
Mercury	EP Toxicity	0.0002	Selenium	EP Toxicity	0.1

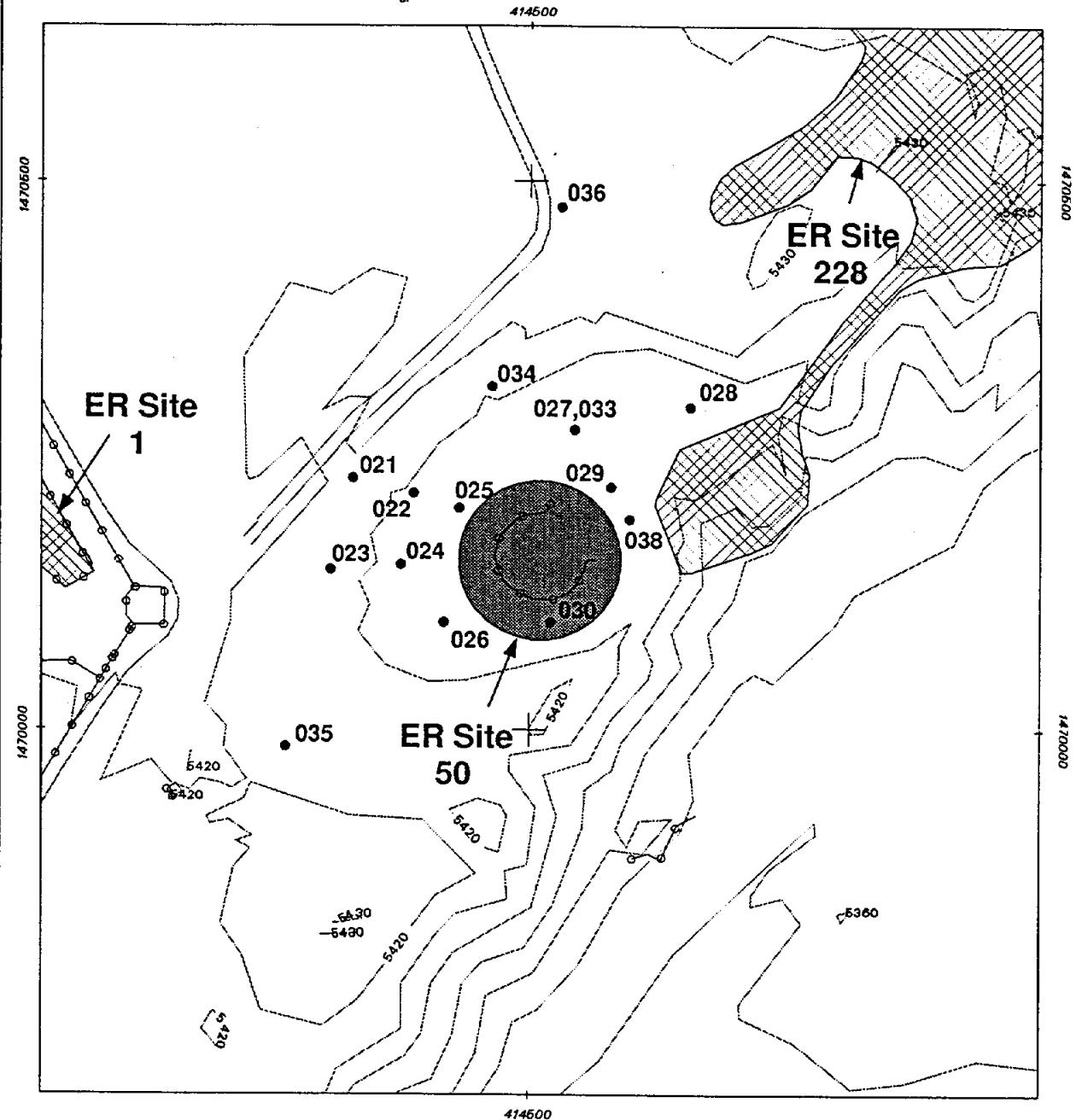
<sup>1</sup> The sample was not a true duplicate because it was taken at the same location but at a slightly different depth.

Table E-2. Non-Detected Constituents (organic)

Constituent	Analytical Method	Detection Limit (mg/kg)
2,4,6-TNT	USATHAMA LW02	0.00192
Gamma hexachlorocyclohexane	EPA 509B	0.00005
Heptachlor	EPA 509B	0.00005
Chlordane	EPA 509B	0.0005
Endrin	EPA 509B	0.0001
Toxaphene	EPA 509B	0.001
Methoxychlor	EPA 509B	0.0005
2,4-Dichlorophenoxyacetic acid	EPA 509B	0.001
2,4,5-Trichlorophenoxypropionic acid	EPA 509B	0.0005
2,4,5-Trichlorophenoxyacetic acid	EPA 509B	0.0005
Phenol	EPA, CLP, GC/MS	0.01
Pyridine	EPA, CLP, GC/MS	0.01
bis (2-chloro-ethyl) ether	EPA, CLP, GC/MS	0.01
1,4-Dichlorobenzene	EPA, CLP, GC/MS	0.01
1,2-Dichlorobenzene	EPA, CLP, GC/MS	0.01
2-Methyl-phenol	EPA, CLP, GC/MS	0.01
3-Methyl-phenol	EPA, CLP, GC/MS	0.01
4-Methyl-phenol	EPA, CLP, GC/MS	0.01
Hexachloroethane	EPA, CLP, GC/MS	0.01

Table E-3. Range of Concentrations (HSL inorganic constituents in mg/kg and Uranium in pCi/g and ug/g)

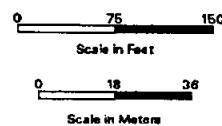
Constituent	Maximum	Minimum	Constituent	Maximum	Minimum
Aluminum	8750	3570	Magnesium	5620	2770
Arsenic	2.8	1.9 (ND)	Manganese	282	50.1
Barium	286	86.8	Sodium	5880	908 (ND)
Calcium	157000	22500	Nickel	7.9	7.3 (ND)
Chromium	7.7	2.5	Lead	11.2	1.8
Copper	16.3	7.7	Titanium	369	38.3
Iron	8880	3060	Vanadium	25.2	14.1
Potassium	2160	985 (ND)	Zinc	25.3	7.3
U-234	1.0±0.2 pCi/g	0.4±0.2 pCi/g	U-235	0.06±0.06 pCi/g	0.00±0.05 pCi/g
U-238	1.1±0.2 pCi/g	0.4±0.1 pCi/g	Total U	1.4 ug/g	0.91 ug/g



### Legend

- Approximate Soil Sample Location
- 10 Foot Contours
- ==== KAFB Roads
- Fences
- [ ] Buildings
- [ ] ER Site 50
- [ ] Other ER Sites

Figure E-1  
ADS 1309  
ER Site 50 Area  
Reconnaissance Sampling



Sandia National Laboratories, New Mexico  
Environmental Restoration Geographic Information System

Figure E-1. Old Centrifuge Site 50

No Further Action Proposal (Site 50)

E-3